Working Copy

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) WORK PLAN

RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Prepared for
BASF Corporation
Wyandotte, Michigan

April 19, 1999

URS Greiner Woodward Clyde
A Division of URS Corporation

30775 Bainbridge Road
Suite 200
Solon, Ohio 44139
(440) 349-2708
Project No. 38-08E060216.00

TABLE OF CONTENTS

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

The Riverview Site is located north of the intersection of Riverside Drive and Jefferson Avenue in Riverview, Michigan, Wayne County. Figure 1-1 is a Site Features Map of the Riverview Site (Site) that illustrates site conditions. Wyandotte Chemicals Corporation originally purchased the property from the Firestone Steel Company in 1951. Wyandotte Chemicals began filling the property during mid to late 1950s. As of the 1960s, the land surface was brought up to the present elevation and configuration.

In mid to late 1970s, BASF Wyandotte Corp. sold the ~~property~~ to Federal Marine Terminals (FMT). During development of the property, buried trash was uncovered in late 1979. As a result of this discovery, FMT, U.S. EPA and Michigan ~~Department~~ of Natural Resources (MDNR) sued BASF.

As a result of these lawsuits, the property reverted to BASF Corporation' ownership. BASF, MDNR, and EPA entered into a Consent Decree that was signed in July 1984. The Decree provided that:

- Two contaminated areas would be capped with compacted clay and a vegetative cover.
- Monitor wells would be installed in selected locations to measure groundwater elevations.
- Samples of groundwater would be collected from the wells on a quarterly schedule.
- Groundwater samples would be analyzed for six selected chemicals of concern.
- Run-off would be controlled by installing three diversion ditches.
- The site would be inspected semiannually and maintained for 30 years.

Since 1984, BASF has complied with all construction, monitoring, and reporting requirements in the Consent Decree.

During the summer of 1998, BASF discovered an area of distressed vegetation on the eastern part of the property. Upon examination, BASF discovered the area was east of the North Cap Area and west of a partially completed slurry wall. The area also has on occasion displayed an elevated water table. Soil samples from the area reported high concentrations of salts and a high pH. These results were shared with the Department of Environmental Quality (DEQ). Since September 1998, BASF has been working cooperatively with the DEQ to develop a remedial strategy for the Riverview property. In March 1999, BASF had several meetings to coordinate additional groundwater and surface water sampling with DEQ and develop an approach for further investigation of hydrogeological conditions. As a result of these meetings, it was agreed that BASF would provide a Work Plan to DEQ that describes a focussed investigation. The following sections describe the approach that BASF will be using to further address groundwater and remedial issues at the Site.

1.1 PROJECT OBJECTIVES

This Work Plan describes the activities to be performed at the Site. The overall approach to this project will be to further assess the site hydrogeologic conditions and evaluate remedial alternatives using the Engineering Evaluation/Cost Analysis (EE/CA) program. As part of the EE/CA investigation, the following objectives will be satisfied:

- Assess the hydrogeological conditions and subsurface water quality at the Riverview Site.
- Evaluate the integrity of the existing capped portions of the landfill and their ability to perform intended functions.
- Assess and remove oily material found in one monitoring well.
- Evaluate potential response actions or remedial measures to ensure BASF's compliance with environmental regulations.

The overall approach used during the EE/CA project will involve the following methodology and sequence of work elements:

- Collect supplemental information to fill in data gaps in the existing database. Since the site has thirteen existing monitoring wells and monitoring has been ongoing as part of the existing Consent Decree, the following media will be the focus: 1) assess the vertical and horizontal extent of Chemicals of Concern (COCs) in the groundwater beneath the site and near surface water mixing zones, and 2) evaluate the integrity and performance of the existing remedial measures that have been performed as part of the 1984 Consent Order.
- Develop remedial alternatives that are protective of human health and the environment and that meet groundwater surface water interface (GSI) criteria for mixing zones.

1.2 WORK PLAN ORGANIZATION

This Work Plan outlines the activities to be performed as part of the EE/CA. It is intended to provide a description of site history and chemical usage and to present the Scope of Work that will be implemented to fulfill the EE/CA objectives. A Sampling and Analysis Plan (SAP), including the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP), are provided in Appendices A and B, respectively.

The text portion of this Work Plan is divided into six (6) sections. Section 1.0 is the introduction and describes the project objectives and organization. Information regarding historical property uses physical setting and a summary of previous investigations is presented in Section 2.0.

Section 3.0 presents the Site Conceptual Exposure Model (SCEM) and discusses potential pathways and receptors, investigative data gaps, and potential remedial technologies for protecting human health and the environment. The specific EE/CA Scope of Work is discussed in Section 4.0 and consists of the following tasks:

- Subsurface investigation near Well-M;
- Groundwater Investigation;
- Landfill Cap Investigation; and
- Slurry Wall Delineation.

Key elements of the SAP and the QAPP are summarized in Section 5.0. A project schedule is discussed in Section 6.0.

This section provides a summary of known site conditions. Information related to site history, physical setting and work completed as part of the 1984 Consent Order is provided in the following sections.

2.1 HISTORY

Wyandotte Chemicals Corporation purchased the property from the Firestone Steel Company in 1951. Historical aerial photographs show the property was undeveloped and vacant at the time of the purchase. The eastern half of the property appears to have been a marshland, and the western half was occupied by open fields. Wyandotte Chemicals began filling the property during the mid to late 1950s, and by the late 1960s, the land surface was essentially at its present size and shape.

According to historical information, the vast majority of the materials used to fill the property consisted of demolition debris, rocks, dirt, and clay. Other materials brought to the site consisted of off-spec materials from the West Plant (the consumer products division), discarded glassware from the laboratories, soda ash, and general plant refuse (trash) from the North and South Works. Some historical information describes site access as being uncontrolled, and anyone wishing to dump unwanted debris on the property was able to do so.

The thickness of the fill materials increases from west to east. The western side of the property was not filled to any great extent. Where subsurface information is available, it shows the fill is less than five feet thick, and in most areas it is less than three feet thick. The eastern side of the property received the bulk of the fill. Not only was the shore moved some 150 feet eastward, but the fill reaches a maximum measured thickness of 23 feet along the eastern boundary.

Filling along the shore made it possible to dock ships at the property. During the 1960s and 1970s, Wyandotte Chemicals Corporation (and possibly BASF Wyandotte Corporation) tied ships to the property and unloaded limestone and coal. These raw materials were stored at the Riverview property intermittently as a hedge against shipping difficulties during labor disputes.

Also during the 1960s and 1970s, BASF Wyandotte Corporation allowed rock salt to be stored on the property. The most reliable information indicates the Wayne County Road Commission owned the salt. Analytical work on the rock salt reportedly found small amounts of arsenic oxide, and this finding was presented to the MDNR.

BASF marketed the site for development during the mid to late 1970s. Ultimately, Federal Marine Terminals (FMT) purchased the 30-acre parcel after two environmental surveys and numerous soil and water samples showed the site was contaminated with a variety of organic and inorganic chemicals. Chemicals found at the Riverview Site include: pentachlorophenol, arsenic, mercury, benzo(a)pyrene, and naphthalene.

In spite of this knowledge, FMT consummated the sale and began construction. When the presence of buried trash was uncovered during excavation in late 1979, FMT, EPA, and MDNR sued BASF.

As a result of these lawsuits, the property reverted to BASF Corporation's ownership. BASF, MDNR, and EPA entered into a Consent Decree that was signed in July 1984. The Decree provided that:

- Two contaminated areas would be capped with compacted clay and a vegetative cover.
- Monitor wells would be installed in selected locations to measure groundwater elevations.
- Samples of groundwater would be collected from the wells on a quarterly schedule.
- Groundwater samples would be analyzed for six selected chemicals of concern.
- Run-off would be controlled by installing three diversion ditches.
- The site would be inspected semiannually and maintained for 30 years.

BASF complied with all construction, monitoring, and reporting requirements in the Consent Decree.

In 1985, BASF leased a four-acre portion of the property to the City of Riverview. The City used the parcel to expand parking for their boat launch facility adjacent to the toll bridge. This lease arrangement was approved by the EPA and the MDNR.

BASF complied with the terms of the Consent Decree by inspecting the property regularly, collecting groundwater samples and water elevations quarterly, and submitting all required reports to the EPA and to the MDNR. (The Department of Environmental Quality, or DEQ, took over the MDNR's responsibility for the site in 1994.)

During the summer of 1998, BASF discovered an area of distressed vegetation on the eastern part of the property. Upon examination, BASF discovered the area was east of the North Cap and west of a partially completed slurry wall. The area also displays an elevated water table. Soil samples from the area had high concentrations of salts and a high pH. These results were shared with the DEQ. Coincidentally, the DEQ was reviewing file information for the Riverview property and requested BASF personnel to provide clarification. Since September 1998, BASF has been working cooperatively with the DEQ to develop a remedial strategy for the Riverview property.

2.2 GENERAL GEOLOGY

The oldest geological units encountered at the Riverview site are carbonate bedrock units. Two boreholes in the southwestern portion of the property encountered dolomitic bedrock at depths of approximately 50 feet. Six boreholes in the eastern and northern portions of the property encountered limestone at depths of approximately 50 feet. If these descriptions are accurate, the limestone unit is likely the Devonian Dundee Formation and the dolomites are likely the uppermost portion of the Detroit River Group. Bedrock maps prepared by the Department of Natural Resources (Mozola 1969) show the Dundee Limestone to be the uppermost bedrock unit in this area.

The bedrock is overlain by a gray silty clay. This clay unit reaches a maximum measured thickness of 33 feet under the site, and it probably represents a till deposited during the latest glacial stage. This unit is typical of the clay tills found throughout Southeastern Michigan. Some boring logs describe a sandy, gravelly clay unit with rock fragments at the base of the till. This unit may represent an erosional conglomerate on top of the bedrock.

The gray clay till is overlain by a brown and gray silty clay. This clay unit is present in nearly every boring on site. It probably is equivalent with the underlying gray clay but represents a weathered zone on top of the larger clay till unit. The upper contact on the clay is sharp and most likely unconformable. Both varieties of clay are very dense; tests report permeability values in the 10^{-7} cm/sec range (Dillon 1989).

The clay till unit is overlain by one of three different units: the Native Sand Unit, the Peat Layer, or fill. Each unit is described below.

The Native Sand Unit is younger than the clay till and older than the Peat Layer. The Native Sand Unit is composed of fine to medium grained, unconsolidated sand grains with traces of silt and clay. Twelve boring logs from the Riverview property describe a thin sand unit under the site. All borings are on the eastern half of the property. BASF believes this sand unit correlates in time of deposition and in depositional environment with the Native Sand Unit found under the North Works site. Where encountered under the North Works site, this sand is well sorted, cohesive, very loose, and saturated. Some samples display cross bedding. Roots from the overlying Peat layer are abundant and trace fossils (worm burrows) are common. BASF's experience on the North Works property shows that this sand unit occupies depressions in the surface of the underlying clay unit, and the sand may not be continuous even across relatively small areas. The sand unit probably represents channel fill deposits from the Detroit River, and the size of the particles indicates the load capacity of the moving water.

The Peat Layer is the youngest naturally occurring sedimentary unit at the Riverview property. Where the layer occurs, the sediments are described as "black, organic, clay, silt", "black sand and organic muck," or "peat". Boring logs do not describe this unit under the western portion of the Riverview property, but they illustrate a thickening of the unit in an eastward direction. Historical aerial photographs show the eastern portion of the site to be underwater or an emergent marsh, depending on the water level in the river at the time the photograph was taken. The sediments in the Peat Layer represent deposition in a marshy, shallow portion of the Detroit River probably similar to present-day Humbug Marsh.

Where encountered elsewhere along the Detroit River, the Peat Layer consists of peat and soft, lean, black clay. The unit has a high organic content. The thickness of this unit varies between zero and a few feet. At some locations, the Peat Layer is dry while at others it is wet. The unit likely forms at least a poor confining layer.

The fill unit overlies the entire surface of the property. The composition of the material changes from place to place, but can be characterized generally as demolition debris, earthen materials, and plant trash. In some areas, the fill is described as "chemical wastes" but very few adjectives are used to discriminate further. The limited information available from people who worked on the property describe the fill as containing concrete rubble, scrap metal, glassware, soda ash, caustics, cardboard and steel drums, coke, cinders, bricks, carbon anode and cell parts, surfactants, and miscellaneous trash from all the Wyandotte plants. After all filling operations ceased, the surface of the property was groomed with crushed limestone to form a durable surface to drive on and to store bulk commodities.

Today, the surface of the property is covered with topsoil and clay. A generalized cross section illustrating site conditions is presented in Figure 1-3. The two capped areas cover approximately one-half the property. Two feet of compacted clay and six inches of topsoil comprise the cap materials. Elsewhere on the property, only the topsoil dressing is known to be present. The vegetation on site is limited to grasses. The Consent Decree specifically prohibited deep-rooted plants because they could damage the cap.

2.3 SUMMARY OF EE/CA DATA NEEDS

As described in the preceding section, the Riverview Site has been partially remediated by installing two clay caps and the groundwater has been monitored during the past 15 years. The extent of fill areas within the site boundaries has been extensively investigated. The COCs used during the monitoring portion of the existing 1984 Consent Order have been identified as: naphthalene, benzo(a)pyrene, pentachlorophenol, PCBs, mercury, and arsenic. Results from recent sampling indicate that several additional VOC, SVOCs and metals parameters exceed GSI generic screening concentrations and, therefore, additional parameters will be analyzed in future studies. The recent monitoring and sampling events have provided data to identify three (3) media that have data needs and will require further investigation in the EE/CA. These media include the following:

- Groundwater in perimeter areas of the site and vertical depths within underlying clay soils.
- Soil conditions within the two existing landfill cap areas.
- Subsurface soil in areas where oil has been observed and near the existing partial slurry wall.

Sections 3.0 and 4.0 of the EE/CA Work Plan identify Data Quality Objectives and describe the EE/CA Scope of Work that is planned for the Site. The Sampling and Analysis Plan (Appendix A) provides the methodology for collecting and analyzing the landfill cap samples, subsurface soil, and groundwater samples that have been identified for completing the EE/CA.

This section describes the Data Quality Objective (DQO) process that has been used in developing the EE/CA workscope. DQOs are statements that define the type, quality, and quantity of data needed to support defensible risk management decisions. They are developed by a systematic process, defined by USEPA as the DQO process (USEPA 1993a). When used, they are an effective tool in developing sampling designs and avoiding the collection of data that are inconsequential to decision making. As part of the EE/CA for the Site, the DQO process will accomplish the following:

- Clarify the objectives of the EE/CA;
- Specify how the sampling data will be used to support decisions;
- Define the most appropriate type of data to collect:
- Specify the quantity and quality of data to be collected; and,
- Specify decision errors for establishing the quantity and quality of data.

The DQO process consists of the following seven steps:

- Step 1: State the Problem - Concisely describe the problem to be studied;
- Step 2: Identify the Decision - Identify the decisions that will solve the problem using media sampling results;
- Step 3: Identify the Inputs to the Decision - Identify the information needed and the resulting measurements that need to be taken to support the decision. These include sources for each item of information and information needed to establish action levels;
- Step 4: Define the Study Boundaries - Specify the conditions (time periods, spatial areas, and situations) to which the decisions will apply and within which the data will be collected;
- Step 5: Develop a Decision Rule - Define the conditions by which the decision-maker will choose among alternative risk management actions. This is usually in the form of an "if..then" statement;
- Step 6: Specify Acceptable Limits on Decision Errors - Define, in statistical terms, the decision maker's acceptable error rates based on the consequence of making an incorrect decision. A decision error rate is the probability of making an incorrect decision based on data that inaccurately estimates the true conditions at the site; and
- Step 7: Optimize the Design - Evaluate the results of the previous steps and develop the most resource-efficient design for data collection that meets all DQOs.

Each of these steps is applied to the objectives described for the EE/CA work scope identified in Section 1.1. The following sections describe the specific DQOs for the Site.

3.1 STATEMENT OF THE PROBLEM

The first step of the process is to state the problem to be studied concisely. The purpose of this step is to define clearly the problem that requires new environmental data so that the focus of the study will be clear and unambiguous.

Therefore, the problem to be addressed in this EE/CA involves developing a Response Action Objective for the Site. This Response Action Objective will need to focus on preventing or reducing exposure to COCs and thus protect human and ecological receptors. Considering the extensive database that exists for the Site, the COCs for the EE/CA include the following:

- 1984 Consent Order Parameter List:
  - » Benzo(a)pyrene
  - » Naphthalene;
  - » Pentachlorophenol;
  - » PCBs (1 Well);
  - » Arsenic; and
  - » Mercury
- Additional Parameter List for GSI generic exceedances.

Groundwater samples were collected by BASF and MDEQ in March 1999. The results from this sampling event were reviewed and compared to Industrial-Commercial GSI criteria listed in Part 201 of the Natural Resources and Environmental Protection Act. Concentrations of the following parameters exceed GSI criteria in the wells near the Trenton Channel. The following additional parameters will be added as COCs during future investigative work.

- » Ammonia
- » Cyanide
- » Chromium
- » Lead

- » Acenaphthene
- » 2,4-dimethylphenol
- » Fluorene
- » Bis (2-ethylhexyl) phthalate
- » 2-methylphenol
- » Phenol
- » Phenanthrene
- » Acetone
- » Methylene Chloride
- » Vinyl Chloride
- » Xylenes

The lateral and vertical extent of the subsurface water contained within the landfilled areas of this Site will be the focus of this investigation. The previous investigations that have been conducted on-site have described the hydrogeology and provided an adequate delineation of COCs in subsurface water within the landfilled areas of the Site. These COCs have been detected principally in subsurface sampling results obtained from the landfilled material and not from groundwater bearing formations. In particular, the mixing zone between the landfilled area and Trenton Channel (Detroit River) will be evaluated in terms of GSI compliance issues.

3.2 IDENTIFICATION OF THE DECISION

The second step of the process is to identify decisions that will solve the problem. The purpose of this step is to identify the decisions that will use environmental data to address the potential contamination problem and to state the actions that could result from the resolution of each decision statement.

At the Site, two primary decisions are to be made prior to implementation of a Response Action and consist of the following:

- What Response Action Objectives are required to adequately protect human health and the environment?
- What Response Action Alternative(s) will be adopted on the Site to achieve the Response Action Objectives and meet GSI compliance?

3.3 IDENTIFICATION OF THE INPUTS INTO THE DECISION

The third step of the process is to identify information needs. The purpose of this step is to identify the information inputs that will be required to resolve the decision and evaluate which inputs require environmental measurements.

3.3.1 Site Conceptual Exposure Model

A Site Conceptual Exposure Model (SCEM) that depicts the pathways and media by which exposure to COCs may occur at the Riverview Site is shown in Figure 3-1. Observations made at the Site and a review of previous investigations were used to develop the exposure scenarios depicted in the SCEM. The SCEM will be updated as the investigation progresses.

As shown in Figure 3-1, the SCEM begins with the primary source of chemicals being a result of historical landfilling operations. When the COCs are released to environmental media they can migrate via surface runoff, subsurface leachate or on the existing cover soils of the landfilled areas.

Once the COCs have reached the surface water, groundwater or surface soils, there are three possible receptors, if exposure pathways are present. On-site workers potentially can be exposed to COCs by way of direct contact with water, soil and/or volatile emanation to either ambient or indoor air. Ingestion, dermal contact and inhalation are the potential routes of exposure. Off-site residents potentially can be exposed to COCs in surface runoff water, sediment and water in the Detroit River. Ingestion and dermal contact are the potential routes of exposure. Ecological receptors potentially can be exposed to COCs by way of direct contact with surface runoff, sediment or water in the Detroit River. Ingestion and dermal contact are the potential routes of exposure.

In summary, the SCEM provided in Figure 3-1 depicts the potential complete and significant exposure pathways for on-site workers, off-site residents and ecological receptors. Previous sampling has defined the COCs present in the subsurface water within the landfilled area of the Riverview Site. The Work Scope for this investigation will address data gaps related to hydrogeological conditions and groundwater flow rate in the mixing zone area. In addition, the investigation will collect data to evaluate the performance of ~~the capped~~ portion of the landfill. The potentially significant pathways depicted on the SCEM will be verified. At the conclusion of the investigation, the Response Action Objectives will be refined using updated hydrogeological data, analytical sampling of the groundwater media, and evaluation of the GSI mixing zone along the Trenton Channel. ?

3.3.2 Decision Inputs

The major decisions required during preparation of the EE/CA Report will include the following:

- Develop Response Action Objectives that will protect human health and the environment; and
- Select Response Action Alternative(s) that achieve the Response Action Objectives and meet GSI compliance.

The following information is needed to support these decisions:

- Refinement of the preliminary SCEM that depicts complete and potentially significant pathways;
- Delineation of the lateral and vertical extent of COCs in subsurface water and groundwater;
- Periodic water level data to confirm water flow in landfilled areas and to evaluate movement of groundwater venting to the Trenton Channel;
- Evaluation of the performance of the existing Landfill Cap; and
- The Response Action Objectives will focus alternatives on presumptive remedies that prevent or reduce exposure to COCs and thus protect human health and the environment. Response Action Alternatives will be developed for those COCs identified in subsurface groundwater and the mixing zone that warrant remedial activity. ?

3.3.3 Data Quality Requirements for Chemical Analysis Data

Groundwater samples used to delineate extent of COCs will be analyzed for site-specific VOCs, SVOCs and metals. Table 3-1 identifies the parameter list for future groundwater sampling activities. In addition, groundwater samples will be analyzed for parameters necessary to evaluate the potential for intrinsic bioremediation processes to occur.

Selected wells will be analyzed for geochemical parameters in order to evaluate the potential natural attenuation. The following parameters will be measured using field meters.

Field

- Dissolved Oxygen
- Redox Potential
- pH

The following parameters will be evaluated by the BASF Inorganic Laboratory in Wyandotte, Michigan:

Laboratory

- Carbon dioxide
- Nitrate
- Phosphate
- Methane
- Sulfate
- Total Iron
- Reduced Iron (Ferrous)
- Chloride
- Alkalinity
- Hardness

ph. hardness for some to calculate spec. cation

Groundwater elevation and surface water ~~elevation~~ measurements in the Trenton Channel will be collected to evaluate flow directions and mixing zone hydraulic connection to the Trenton Channel.

Additional details regarding sampling procedures and analytical requirements are discussed in the FSP and QAPP. This testing will provide an analytical database consistent with previous investigations allowing for evaluation of complete pathways and applicability of presumptive remedies.

3.4 DEFINITION OF THE STUDY BOUNDARIES AND POTENTIAL AREAS CONSIDERED FOR REMEDIATION

The fourth step of the process is to define the study boundaries. The purpose of this step is to define the conditions (spatial and temporal boundaries) to which the decisions will apply and within which the data will be collected.

The temporal study boundaries are expressed as the current and, to some extent, future conditions at the Site. Response Action Objectives will be met for current and future conditions. It is understood that the Site will remain as an industrial land use setting.

Since the existing water analytical results indicate the occurrence of several COCs in subsurface water in the landfilled material beneath the Site, the hydrogeologic investigation will be focused toward perimeter and deep formation sampling. The landfill cap borings will be focused on evaluating the integrity of the existing cap construction. The subsurface soil investigation will be focused on verifying existing data and delineating potential oily source area contamination. The study boundary for the EE/CA includes the perimeter areas of the known landfilled areas and groundwater beneath and adjacent to the Site.

3.5 DEVELOPMENT OF DECISION RULES

The fifth step of the process is to develop decision rules. The purpose of this step is to integrate the outputs from previous steps into a single statement that describes the logical basis for choosing among alternative actions.

Decision rules define the conditions by which the decision-maker will choose among alternative risk management actions. This usually is in the form of an "if...then..." statement.

3.5.1 Decision Rules for Decision No. 1 (Adequacy of Response Action Objectives)

1. If an exposure pathway identified on the Site Conceptual Exposure Model is found to be complete and significant, then a Response Action Objective and a Remedial Action are needed to address that pathway either by eliminating potential exposure or reducing predicted risk.
2. If a Response Action Objective and Remedial Action are needed, then the particular pathway will be addressed that represents a potential risk to human health and the environment.
3. If the preliminary goal of using the mixing zone GSI for groundwater are unachievable using available presumptive remedial technologies for groundwater, then Intrinsic Remediation Techniques or asymptotic groundwater ~~cleanup~~ limits will be established as a long term Response Action Objective based on remedial system monitoring and groundwater monitoring.

3.5.2 Decision Rules for Decision No. 2 (Selection of Remedy)

If continued exposure to subsurface water indicates a threat to human health and the environment, then remedies will be considered for meeting Response Action Objectives. When evaluated in the EE/CA Report, these remedial technologies may include the following separately or in combination: in-situ treatment; natural attenuation; hydraulic control and/or containment; phytoremediation; long-term monitoring; selective capping and infiltration control of surface soil; and deed restrictions.

3.6 SPECIFICATION OF ACCEPTABLE LIMITS ON THE DECISION ERRORS

As described in Section 2.0, there has been a considerable amount of analytical data collected from the Site. The Site has been previously evaluated in terms COCs and extent of filled areas.

Considering the number of samples collected to date, the likelihood of making decision errors is very low at this Site. The COCs have been confirmed during the past 15 years of monitoring and during recent 1999 sampling events. In general, when using USEPA guidance to calculate exposure point concentrations, approximately 15-20 samples are adequate to obtain reliable estimates of the mean and 95 percent UCL. Since, the existing sample numbers exceed these sample quantities, the existing data when combined with the EE/CA investigation sampling results will be adequate for making response action decisions.

3.7 OPTIMIZATION OF THE DESIGN

The seventh step of the process is to evaluate results from previous steps and develop an efficient design for the EE/CA investigation. The purpose of this final step is to identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.

Based on the data requirements identified in Section 3.2, and an evaluation of existing data and EE/CA data needs, a field sampling program has been designed. Optimization of the sampling program has taken place in steps 1 through 6 of the DQO process (Sections 3.1 through 3.6). An overview of the field sampling activities that will be used to satisfy the DQOs is presented in Section 4.0 and describe in detail in the SAP (Appendix A).

The following subsections summarize the EE/CA Scope of Work. Field procedures are discussed in detail in the SAP provided in Appendix A. Specific components of the EE/CA Scope of Work are described in the following subsections.

4.1 SUBSURFACE INVESTIGATION NEAR MONITORING WELLS MW-M AND MW-F

Light non-aqueous phase liquids (LNAPL) have historically been detected in monitoring wells MW-M and MW-F. LNAPL was present in MW-M during the March 3 & 4, 1999 MDEQ and BASF groundwater sampling event. In order to investigate conditions in proximity to MW-M, the Scope of Work includes completion of the following tasks:

- Drill 6 soil borings around Well M and MW-F;
- Three of the borings will be drilled into the native soils to depths of about 25 feet below ground surface (bgs). These borings will be immediately grouted to ground surface:
- Three of the borings will be drilled to the base of the fill material to estimated depths of about 10 to 15 feet bgs. These borings will be converted to temporary piezometers:
- Continuous soil samples will be collected from all six borings to identify depth of fill, soil conditions and occurrence of LNAPL;
- Field screening with photoionization unit (PID) or flame ionization unit (FID);
- Survey horizontal and vertical locations of all borings and temporary piezometers;
- Measure water levels and characterize LNAPL layer;
- Conduct bail down tests in the temporary piezometers and monitoring wells MW-M and MW-F to monitor the LNAPL recovery rate; and
- If an LNAPL is identified in any temporary piezometer or existing well, manually bail LNAPL and install hydrophobic sorbing booms.

Depending on the quantity of LNAPL collected, more active recovery methods such as LNAPL recovery pumps will be considered.

4.2 GROUNDWATER INVESTIGATION

The 13 existing monitoring wells (MW-A through MW-M) were installed as part of the Consent Decree. It appears that most of the monitoring wells have been installed in landfilled and capped areas of the site. Well logs are not available for these monitoring wells. The existing monitoring well configuration does not provide an evaluation of groundwater, but rather the leachate in fill material. The existing wells are acceptable for measuring gradients of liquids in the fill and the downgradient wells can be used in evaluating potential discharge to the Trenton Channel. However, the existing well system does not provide adequate coverage to evaluate groundwater quality and quantity beneath and adjacent to the site.

The objective of this groundwater investigation will be to evaluate vertical and lateral extent of groundwater conditions. In particular, the characteristics of soils underlying the fill and occurrence of groundwater need to be assessed. In order to evaluate groundwater conditions, the following tasks will be completed:

- Install six shallow monitoring wells and six deep monitoring wells to investigate conditions outside of the capped areas. Three shallow and three deep wells will be nested. The shallow wells will be installed to depths adequate for evaluating conditions in the landfilled areas. The deep wells will be installed to depths adequate for evaluating condition in the underlying natural silty clay soils.
- The deep wells that are drilled in fill areas will be set through surface casing to isolate the wells from fill leachate and prevent vertical migration:
- All wells will be constructed of 2-inch PVC risers and screens;
- Collect groundwater samples from new and existing wells;
- Measure water levels from all new and existing wells;
- Perform continuous sampling in order to describe the fill and material soils;
- Perform laboratory hydraulic conductivity testing of soil samples collected using six Shelby tubes pushed into native underlying soils;
- Perform hydraulic conductivity testing (rising head slug tests) on natural water-bearing zones to evaluate formation yields;
- Collect weekly water level measurements from all wells and the Trenton Channel for a period of three months;
- Survey horizontal and vertical locations of all wells; and,
- Collect groundwater samples from below the first encountered water table at three Geoprobe borings located adjacent to the Trenton Channel near the mixing zone.

Groundwater samples from the existing wells, shallow and deep wells and the Geoprobe water samples will be analyzed for parameters included in the original 1984 Consent Decree and parameters that were detected in excess of MDEQ GSI standards during the March 1999 groundwater sampling event. These parameters include arsenic, chromium (total), lead, mercury, ammonia, cyanide, benzo(a)pyrene, phenanthrene, naphthalene, pentachlorophenol, acenaphthene, 2,4-dimethylphenol, fluorene, bis (2-ethylhexyl) phthalate, 2-methylphenol, phenol, acetone, xylenes, methylene chloride, and vinyl chloride. In addition, the groundwater sample collected from MW-B will be analyzed for PCBs

Other field parameters recorded will be Dissolved Oxygen (DO) and Oxygen-reduction Potential (Redox). These parameters will be recorded to support decisions regarding potential remedial activities.

Groundwater samples from the new deep and shallow wells will also be analyzed in the field for hardness. Hardness and final pH readings collected during well purging will be used to determine the GSI value for the MDEQ Part 201 Generic Cleanup Criteria and Screening Levels. The GSI values for lead and chromium are dependent on hardness. These readings will be used to calculate the correct lead and chromium GSI values for the site.

other remedial too

Additional sample volumes may be collected to analyze for geochemical parameters that may support selection of a potential remedial strategy. These include: Nitrate, Manganese(II), Fe(II), Sulfate, Methane, Chloride, and Alkalinity. These analyses may be run in the field or at the analytical laboratory.

4.3 EVALUATION OF EXISTING CLAY CAPS

As illustrated on Figure 2-1, two areas of the site have been capped with clay. The capped areas encompass approximately 10 acres of the 30-acre site. There is little information concerning the design or construction records of these caps. Reportedly the caps consist of approximately 24 inches of clay. The following tasks will be completed in order to evaluate the integrity of the cap and thickness of fill material outside the capped areas:

- Drill 28 shallow soil borings to a depth of 5 feet bgs;
- Perform continuous soil sampling;
- Advance 18 of the cap borings with a Geoprobe;
- Advance 10 cap borings with a conventional drilling rig to collect Shelby tube samples for geotechnical testing;
- Install 14 temporary PVC gas probes to measure gas pressure, CO2, O2 and methane;
- Upon completion of drilling, backfill boring locations with a bentonite/cement grout; and,
- Survey horizontal and vertical locations of all borings.

Ten of the cap borings will be drilled with 4.25-inch ID hollow-stem augers HSA so that Shelby tubes can be collected. Soil samples will be logged and described as discussed in Section 2.4.1 of the Field Sampling Plan. The Shelby tubes will be collected from 10 of the cap borings for geotechnical analysis, as described below. The 10 borings for geotechnical analysis will be distributed spatially to evaluate the extent and composition of the caps and the fill material. As shown on Figure 2-1, the Shelby tubes will be collected from the following 10 cap borings: CAP-1; CAP-11, CAP-15, CAP-18, CAP-19, CAP-22, CAP-24, CAP-26, CAP-27, and CAP-31.

4.4 SLURRY WALL INVESTIGATION

Available information indicates that FMT began construction of a bentonite slurry wall near the Trenton Channel. BASF believes that the wall extends approximately 350 feet southward from the northeast corner of the property. URSGWC completed a review of BASF files; no additional information was available concerning the slurry wall. In order to evaluate the location of the slurry wall, the following activities are proposed:

- Excavate two shallow (0-5 ft bgs) trenches that extend perpendicular to the fenceline. The trenches are anticipated to extend approximate 100 feet in length. An attempt will be made to not disturb the wall;
- Upon completion the trenches will be backfilled with spoils removed; and
- Survey the horizontal location of the slurry wall.

The purpose of this work will be to identify the location of the wall, so if future remedial actions can either supplement or tie-in to this structure when its location is identified. The proposed location of the trenches are presented on Figure 2-1.

4.5 WATER BUDGET HELP MODEL

In order to prepare an estimate of the potential for venting of groundwater from the site, two flow components need to be evaluated. One of the components involves the amount of water that is entering the site from precipitation onto the existing cap. The subsurface information obtained from the Landfill Cap Borings will be used in conjunction with the Hydrologic Evaluation of Landfill Performance (HELP) Model to calculate the amount of water reaching the subsurface fill as a result of infiltration. Results from the HELP Model will be used to develop a water budget for the 30-acre site that includes runoff, runon, evaporation and infiltration.

The second component involves the amount of water that is passing through the site from groundwater seepage entering upgradient locations and discharging through the fill into the river. The groundwater elevations, Trenton Channel elevations and flow rate obtained during the hydrogeological investigation will be used to evaluate hydraulic gradients and groundwater flow rates beneath the Riverview Site.

Sampling and analytical procedures are summarized in the SAP and QAPP provided as Appendix A and B, respectively.

5.1 FIELD SAMPLING PLAN SUMMARY

The FSP provides detailed procedures for all field activities including the collection of subsurface soil samples, test pit excavation, the installation of monitoring wells and the collection of groundwater quality samples. The sample labeling system and procedures for packing and transporting analytical samples is outlined. The FSP also discusses procedures for personnel and equipment decontamination.

5.1.1 Data Acquisition

Subsurface samples will be collected from split-spoons through hollow stem augers. Shallow and deep monitoring well construction is planned during the investigation. In general, the wells will be constructed of PVC casing and sealed from surface infiltration by granular bentonite seals. Monitoring wells will be screened in the shallow and deep portion of the subsurface fill or natural soil units beneath the site. In addition, Geoprobes will be used to collect subsurface water on-site near the Trenton Channel.

5.1.2 Analytical Methods

Groundwater samples collected at the site will be analyzed for select VOCs, SVOCs, metals, PCBs and cyanide using appropriate USEPA SW-846 test methods. Detailed procedures for sample collection, preservation, and shipment are presented in the FSP and the QAPP

5.1.3 Data Analysis and Reporting

Upon receipt from the analytical laboratory, all data will be validated in accordance with the validation procedures and requirements discussed in the QAPP. Following validation, the data will be compiled and summarized for inclusion in the EE/CA Report.

5.2 QUALITY ASSURANCE PROJECT PLAN SUMMARY

The QAPP presents the organization, objectives, and specific quality control/quality assurance (QA/QC) activities associated with the tasks performed for the EE/CA. The QAPP assures that the data collected will be of sufficient precision, accuracy, representativeness, completeness, and comparability to meet DQOs.

The EE/CA for the Riverview Site includes the following milestones:

- Preparing, submitting, and revising the EE/CA Work Plan, and SAP;
- Mobilizing and conducting the EE/CA Field Work;
- Validating and analyzing data; and.
- Preparing, submitting and revising the EE/CA Report.

The schedule assumes receipt of MDEQ comments on each draft document within 30 calendar days. In addition, the schedule assumes no input, delays, or approvals by U.S. EPA. Approval of final documents is assumed to occur within 30 calendar days of submittal of revised documents to MDEQ. Any extension of the review time or approval period would delay the following schedule.

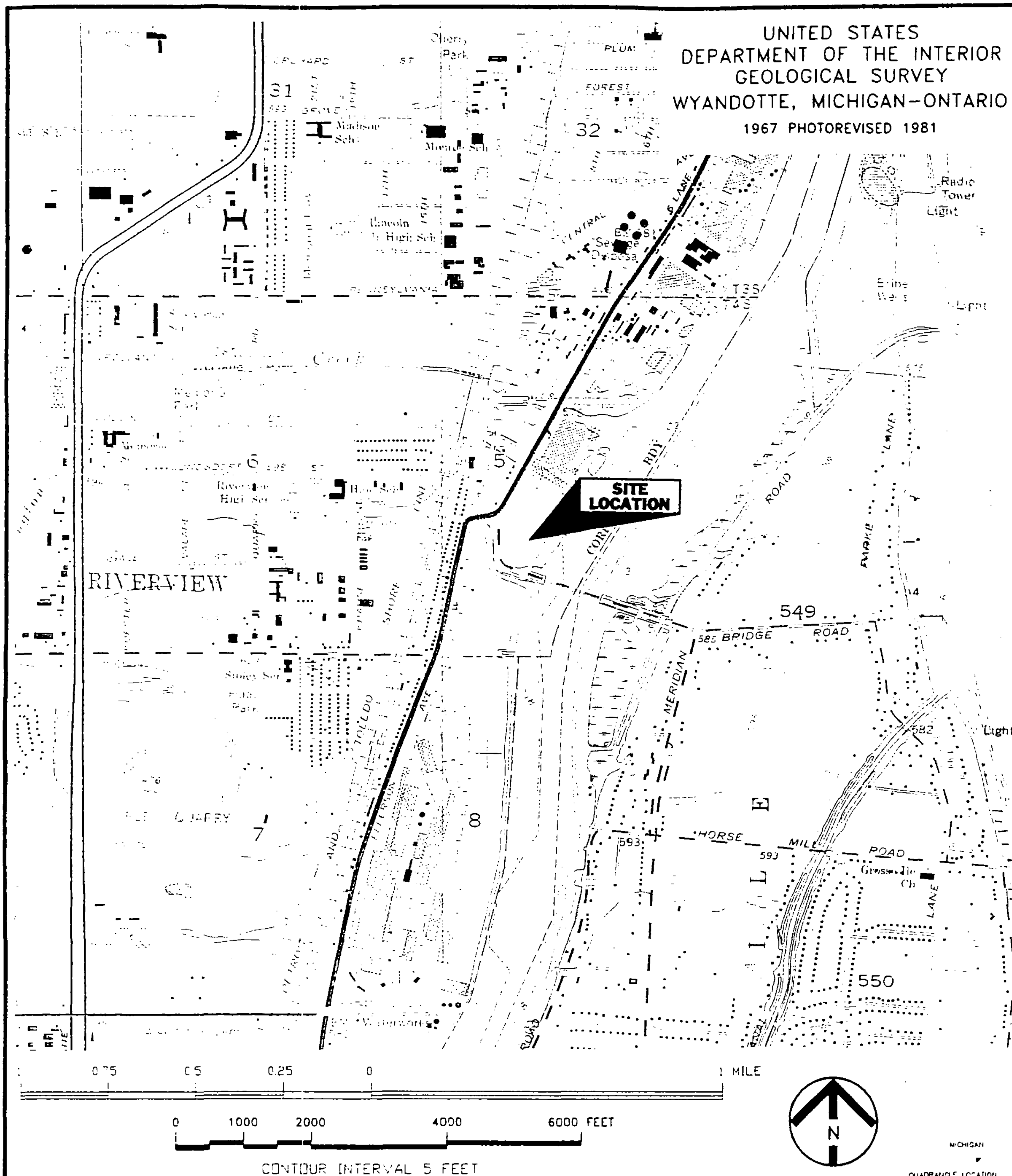
- Submittal of draft EE/CA Work Plan, SAP, and QAPP to MDEQ (**April 20, 1999**);
- Submittal of final EE/CA Work Plan, SAP, and QAPP to MDEQ within 30 calendar days of receipt of MDEQ comments (**June 20, 1999**);
- MDEQ approval of final EE/CA Work Plan, SAP and QAPP (**July 20, 1999**);
- Mobilization for conducting EE/CA Work Plan within 10 business days of receipt of approval of EE/CA Work Plan, SAP, and QAPP (**August 3, 1999**);
- Submittal of draft EE/CA Report to MDEQ 30 calendar days after validation of data (**November 20, 1999**); and,
- Submittal of final EE/CA Report to MDEQ to 30 days after receipt of comments of draft EE/CA (**January 20, 2000**).

Tables

Table 3-1
Parameter List
EE/CA Investigation
Riverview Site, Michigan

Initial Parameter
Benzo(a)pyrene
Naphthalene
Pentachlorophenol
PCBs (1 well)
Arsenic
Mercury
Additional Parameters GSI Exceedances
Acenaphthene
2,4-dimethylphenol
Fluorene
Bis(2-ethylhexl)phthate
2-methylphenol
Phenanthrene
Phenol
Acetone
Xylenes
Methylene Chloride
Vinyl Chloride
Chromium (total)
Lead
Ammonia
Cyanide

Figures



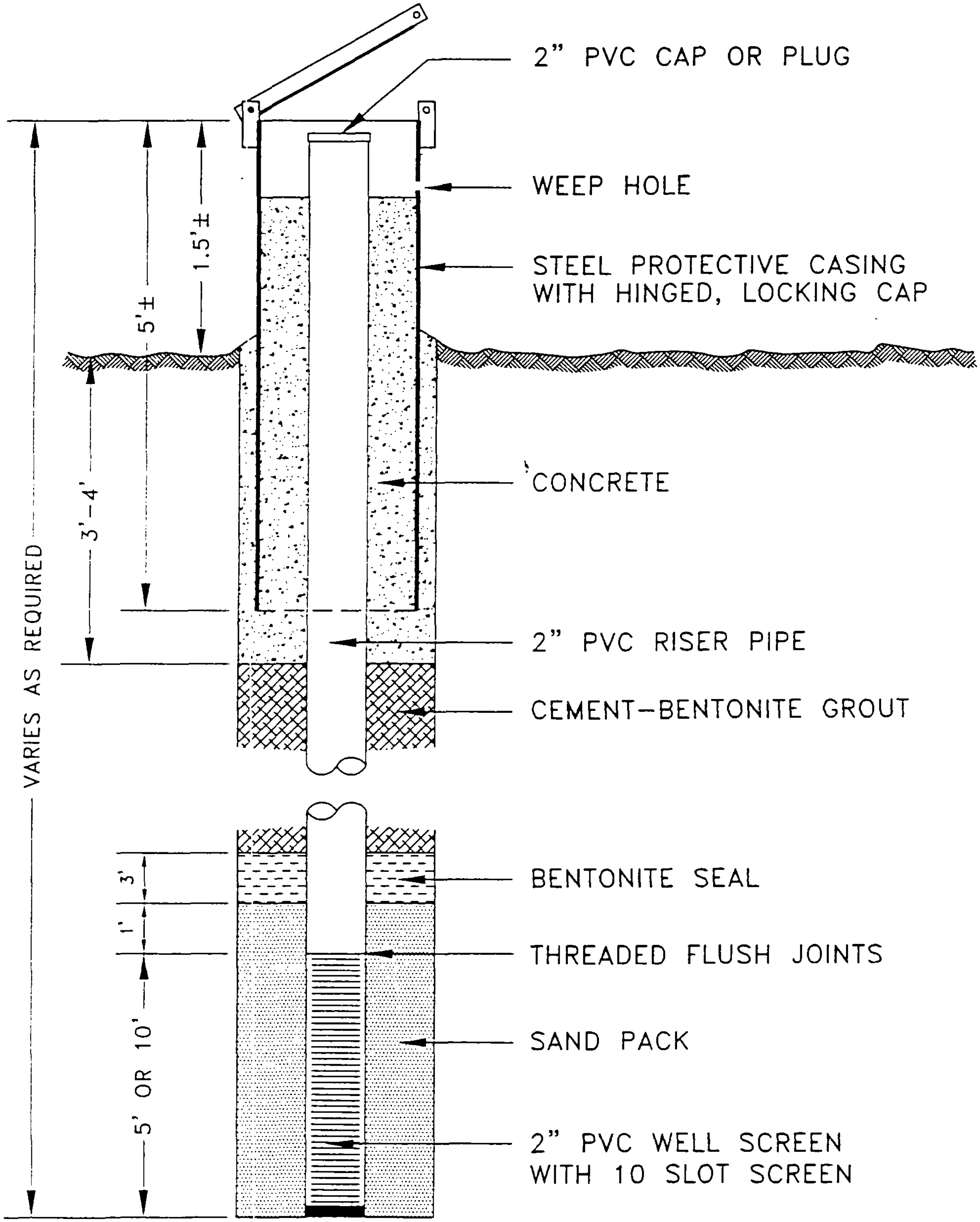
GENERAL LOCATION MAP

BASF PROPERTY - RIVERVIEW, MICHIGAN

DRAWN BY: TBC	CHECKED BY: TLW	PROJECT NUMBER: 8E06216	DATE: 4-18-99	FIGURE NO: 1-1

URS Greiner Woodward Clyde

O:\BASF\8E06216\6216GLM



DRAWING NOT TO SCALE

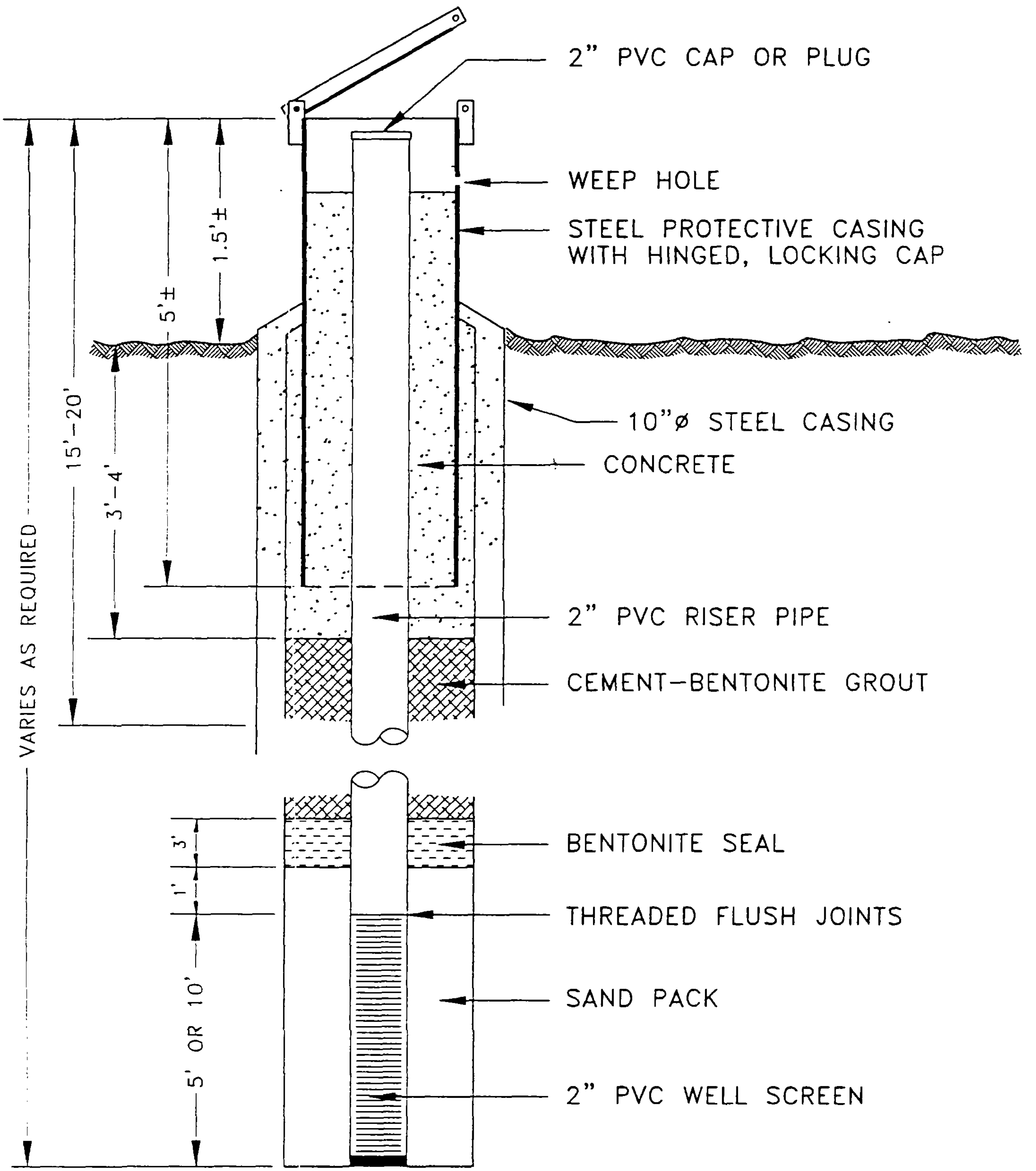
TYPICAL SINGLE CASED MONITORING WELL CONSTRUCTION DIAGRAM

BASF SITE - RIVERVIEW, MICHIGAN

DRAWN BY: MMS	CHECKED BY: MJM	PROJECT NUMBER: 8E06216	DATE: 04-18-99	FIGURE NO: 2-2

O:\BASF\8E06216\WELL1.DWG

URS Greiner Woodward Clyde



DRAWING NOT TO SCALE

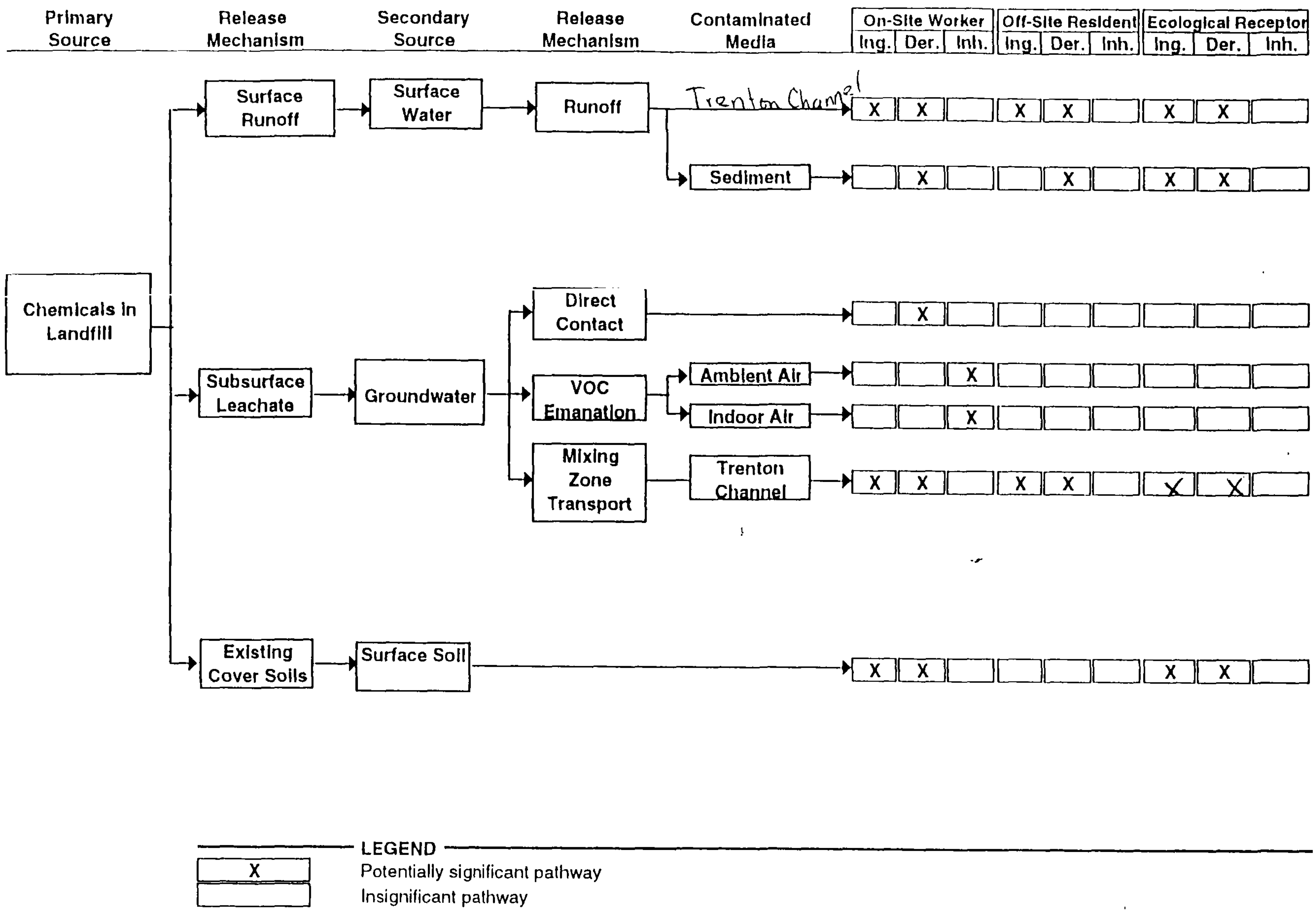
O:\BASF\8E06216\WELL2.DWG

TYPICAL DOUBLE-CASED MONITORING WELL CONSTRUCTION DIAGRAM

BASF SITE - RIVERVIEW, MICHIGAN

DRAWN BY: MMS	CHECKED BY: MJM	PROJECT NUMBER: 8E06206	DATE: 04-12-99	FIGURE NO: 2-3

URS Greiner Woodward Clyde



SITE CONCEPTUAL EXPOSURE MODEL

BASF Site, Riverview, Michigan

Drawn by: MLS	DATE: 04/11/99	PROJECT NO.: 38-08E06216.00	FIGURE NO: 3-1	w:\word\BASF\Riverview\BASFSCEM.xls

Appendix A

APPENDIX A

SAMPLING AND ANALYSIS PLAN / FIELD SAMPLING PLAN

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA)

RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Prepared for
BASF Corporation
Wyandotte, Michigan

April 19, 1999

URS Greiner Woodward Clyde
A Division of URS Corporation

30775 Bainbridge Road
Suite 200
Solon, Ohio 44139
(440) 349-2708

Project No. 38-08E06216.00

TABLE OF CONTENTS

TABLE OF CONTENTS

List Of Figures

This hydrogeologic investigation and Engineering Evaluation/Cost Analysis (EE/CA) is being conducted to provide sufficient information to Michigan Department of Environmental Quality (MDEQ) to select a Response Action for implementation at BASF Corporation's (BASF) site in Riverview (the Site). The response action from this EE/CA will eliminate or mitigate unacceptable risks to human health and welfare and the environment arising from the release or threat of release of hazardous substances, pollutants, or contaminants at and from the Site. The EE/CA will involve a focused investigation of the occurrence of chemicals in the leachate and groundwater underlying the site. BASF retained URS Greiner Woodward Clyde (URSGWC) to conduct this EE/CA for the Site located in Riverview, Michigan. As shown on Figure 1-1, the Site is located at the intersection of Jefferson Avenue and Riverside Drive. As shown on Figure 1-2, Materials Processing Inc.'s Riverview warehouse is located north of the Site and the Trenton Channel is located east of the Site. This location was formerly operated by Firestone.

As discussed in the Work Plan, the Site was owned by BASF and was sold to Federal Marine Terminals (FMT) for development into a docking location for material loading and unloading. There was extensive litigation between BASF, FMT and Region V United States Environmental Protection Agency (USEPA) concerning the origin of constituents of concern (COCs) detected in the leachate found beneath the Site. Following several years of litigation, the Site reverted to BASF's control.

Based on URSGWC's review of existing site information, the following synopsis of site conditions has been developed:

- The eastern two-thirds of the site was filled with debris, rock and waste to create usable land.
- The fill material and waste exists along the river embankment and has a thickness up to approximately 23 feet in the center of the Site.
- The existing monitoring wells have been installed in the fill and are monitoring liquids contained in the fill (referred to as leachate).
- Previous analysis of leachate indicates the presence of metals (e.g., arsenic and mercury) and semi-volatile organic compounds (e.g., benzo (a) pyrene, pentachlorophenol and naphthalene) in the leachate. MDEQ has recently expressed concerns that these COCs may be entering the Trenton Channel.
- A bentonite slurry wall was installed adjacent to the Detroit River. This wall is believed to extend some 350 feet southward from the northeastern corner of the property. However, the exact location of the wall is unknown at the present time.
- The site use is currently vacant land.

BASF's goals for this EE/CA include the following:

- Remove oily material found in one monitoring well to ensure that it is not a continuing source of contamination;
- Assess hydrogeological conditions and groundwater quality;
- Evaluate the integrity of the caps and their ability to perform their intended function; and

- Formulate recommendations for potential remedial actions or remedial measures to ensure BASF's continued compliance with environmental regulations.

The EE/CA Work Plan provides a detailed description of site history and chemical usage and presents the Scope of Work that will be implemented to fulfill the EE/CA objectives. This Sampling and Analysis Plan (SAP) and inclusive Field Sampling Plan (FSP) are provided as Appendix A to the EE/CA Work Plan and outline the activities to be performed. The Quality Assurance Project Plan (QAPP) is provided as Appendix B of the EE/CA Work Plan.

This FSP details the procedures for implementing the EE/CA scope of work. The EE/CA field activities will include:

- In order to evaluate the presence of oily light, non-aqueous phase liquid (LNAPL) in monitoring well MW-M, several shallow and several deep borings will be drilled. Temporary piezometers will be installed in the shallow borings. Bail down tests will be performed on the piezometers; sorbant pads may be used to collect the LNAPL, if present.
- A groundwater investigation will be completed. The objectives of this groundwater investigation will be to evaluate groundwater conditions with respect to the MDEQ Groundwater Surface Water Interface Criteria (GSI Criteria) and hydrogeological properties. Most of the existing monitoring wells are installed in the fill material which evaluate the leachate in the fill material. Additional shallow wells will be installed in the fill material near the site boarder to evaluate the leachate flowing onto the site. Several deeper monitoring wells will be installed in the natural soil to evaluate groundwater quality at the site. In addition, several groundwater samples will be collected using a Geoprobe along the edge of the River to evaluate the COC concentrations in the leachate that may be entering the River. Geoprobe water samples will also be collected from both sides of the slurry wall. Groundwater samples will be collected from new and exiting monitoring wells. The hydraulic conductivity of the natural soil will be evaluated in a geotechnical laboratory and using field slug testing methods.
- The two landfilled and capped portions (approximately 10 acres in size) of the site will be evaluated. No file information was identified regarding the design or construction of these caps. The integrity of the cap and thickness of material placed in other areas will be evaluated by drilling approximately 30 shallow soil borings (approximately 5 feet bgs in depth). Temporary PVC gas probes will be installed in approximately half of the borings to measure gas pressure, CO_2, O_2 and methane. Soil samples from the clay cap and fill material will be tested for geotechnical parameters, including: Atterberg limits, grain size and permeability.
- Available information suggests that a bentonite slurry wall was built near the Trenton Channel. BASF believes that the wall extends approximately 350 feet southward from the northeast corner of the property. The location and construction of the slurry wall will be evaluated by excavating at least two shallow (0-5 ft bgs) trenches that extend approximately 100 feet perpendicular to the fenceline. The purpose of this work will be to identify the location of the wall, evaluate its usefulness, and to utilize it for future remedial actions, if necessary.

All work will be performed in compliance with MDEQ and USEPA regulations. All data will be validated in accordance with USEPA requirements, and data quality will be assured through application of the Quality Assurance/Quality Control measures described in the QAPP (Appendix B of the Work Plan). All fieldwork will be conducted in accordance with a site-specific Health and Safety Plan (HASP) that will be developed for the Site.

Specific information regarding sampling procedures, quantities, types, locations, depths, and analytical parameters are provided in this section. The field activities will be properly documented to allow an accurate reconstruction of field activities.

Before sampling, the appropriate health and safety equipment will be obtained, and the personal protective equipment described in a HASP will be donned. Ambient air monitoring will be performed to characterize the air quality for health and safety purposes and to identify potential contaminant emissions. An air-monitoring instrument such as a photo-ionization detector (PID) or flame-ionization detector (FID) will be used to monitor air quality. Soil samples collected during drilling operations will also be screened with a FID or PID to provide qualitative information concerning soil quality. All instruments will be calibrated daily and the calibration times and readings will be recorded in a field book

2.1 FIELD MOBILIZATION

A utility markout of underground utilities at the site will be requested by calling a utility location service a minimum of three business days prior to beginning intrusive field work. In addition. available historical maps and drawings will be reviewed in an attempt to locate underground utilities. BASF believes there are no utilities buried on the Site that needs to be protected. A current site features map is presented in Figure 1-2. All locations will be approved by BASF personnel before drilling. If necessary, drilling locations may be moved to a nearby BASF-approved location if, in the judgment of URSGWC representative, the location will be adequate to satisfy the objectives of the investigation.

The subcontracted driller (or drillers) will construct a temporary decontamination pad for decontaminating augers and sampling equipment and containerizing decontamination water. The decontamination pad will be designed to retain and collect decontamination water for storage in 55-gallon drums prior to off-site disposal pending analytical results. A temporary drum storage area will be established for containerized water and soil.

2.2 SUBSURFACE INVESTIGATION NEAR MW-M

LNAPL has historically been detected in monitoring well MW-M and MW-F. LNAPL was present in MW-M and MW-F during the March 3rd and 4th, 1999 MDEQ and BASF groundwater sampling event. In order to investigate conditions in proximity to MW-M and MW-F, this FSP includes completion of the following tasks:

- Drill six soil borings through fill surrounding MW-M and MW-F;
- Three of the borings will be drilled into the native soils (brown silty clay and the gray clay till) to depths of about 25 feet below ground surface (bgs). Upon completion of sampling, these borings will be grouted to the ground surface;
- Three of the borings will be drilled to the base of the fill material to estimated depths of about 10 to 15 feet bgs. These borings will be converted to temporary piezometers;
- Continuous soil samples will be collected from all six borings to identify depth of fill. soil conditions and occurrence of LNAPL;

- Field screening with PID or FID;
- Survey horizontal and vertical locations of all borings and temporary piezometers;
- Measure water levels and characterize LNAPL layer;
- Conduct bail down tests in the temporary piezometers and monitoring wells MW-M and MW-F to monitor the LNAPL recovery rate; and
- If an LNAPL is identified in any temporary piezometer or existing well, manually bail LNAPL and install hydrophobic sorbant booms.

2.2.1 Borehole Drilling

URSGWC will drill six exploratory soil borings to evaluate subsurface conditions near MW-M and MW-F. The proposed drilling locations are shown on Figure 2-1. Three shallow borings will be drilled to the base of the fill material, an anticipated depth of 10 to 15 feet bgs. These borings will be converted to temporary piezometers. Three deep borings will be drilled through the Peat Layer, the Native Sand Unit, the brown silty clay, and into the gray clay till to an anticipated depth of 25 ft bgs.

All borings are intended to evaluate the clay cover and the fill material. The deeper borings are also intended to evaluate the natural soil units. The three shallow borings will be drilled with 6.25-inch inside diameters (ID) hollow-stem augers (HSA) since these wells will be converted to temporary 4-inch diameter piezometers. The three deeper borings will be drilled with 4.25-inch ID HSA and will be grouted to the ground surface immediately following drilling to prevent downward migration of leachate into groundwater. A cement-bentonite grout will be used.

During drilling of all six borings, soil samples will be collected continuously to the termination depth. Soil samples will be collected using a split-spoon sampler in general accordance with ASTM D-1586. Existing facility information suggests that leachate is present in the fill material at a depth of 6 to 10 ft bgs. The depth to groundwater in the natural soil is not known, at this time.

The soil type, moisture content and other pertinent observations (such as the presence of LNAPL) will be logged by the URSGWC on-site representative per USGS protocol at the time of drilling. Upon collection, each split-spoon will be opened, logged, sampled, and field screened by URSGWC's on-site representative. Each sample will be divided lengthwise upon retrieval. A portion of the sample will be placed in a separate clean container and used for field screening using a FID or PID. No soil samples will be retained for chemical analysis.

Headspace analysis will be used to field screen soil samples for relative concentrations of volatile organic compounds (VOCs). Soil samples subjected to headspace screening will be held at ambient temperature and exposed to ambient temperatures for at least 10 minutes. The probe of a FID or PID will then be inserted into the sample container. The maximum total organic vapor concentration observed with this procedure will be recorded as the headspace value for that sample. The headspace reading will be recorded in the field book by the URSGWC representative.

Decontamination water generated during these tests will be containerized in 55-gallon drums and managed as described in Section 8 of this FSP. Soil will be staged on Site or placed in a roll-off box as directed by BASF representatives.

2.2.2 Temporary Piezometer Installation

The three shallow soil borings drilled near MW-M will be completed as temporary piezometers. They will be constructed of 4-inch diameter, flush-threaded, Schedule 40 PVC casing. The piezometer screens will extend from one foot above the leachate to several feet into the leachate. It is anticipated that 10-ft of 0.010-inch slotted screen will be used. A bottom plug will also be installed. A five-gallon bucket and will be inverted and placed over each of the temporary wells. Bentonite powder will be placed around the lip of each buck to minimize the likelihood of rain infiltrating the temporary wells.

The horizontal and vertical locations of all borings and temporary piezometers will be surveyed by a local professional surveyor. The depth to water will be measured and recorded as described in Section 2.3.6 of this FSP.

2.2.3 Water Level Measurements

Static water levels and the total depth of the temporary piezometers will be measured and recorded in the field book. Static water level and total depth measurements will be made from the top of the PVC riser to the nearest 0.01-foot. The measuring point for all the piezometers will be the top of the casing at the north rim. If a reference mark is not found, all readings will be referenced to the north rim of the casing.

2.2.4 LNAPL Evaluation and Removal

If LNAPL is encountered in any the temporary piezometers, or existing monitoring well, the LNAPL thickness will be estimated using an oil/water interface probe or with a 2-inch diameter single-use high-density polyethylene (HDPE) bailer. Bail-down tests will be completed by bailing out the existing LNAPL using 2-inch or 4-inch diameter HDPE bailers, as necessary. An effort will be made to minimize the volume of leachate removed while bailing. Following reduction of the LNAPL thickness to the extent practicable, the LNAPL recovery rate will be monitored by measuring the LNAPL thickness every 10 minutes for one-hour. In an effort to conserve time, multiple tests may be completed simultaneously. Hydrophobic booms will be used to continue to recover LNAPL from any monitoring wells, as necessary. The hydrophobic booms will be lowered into the well on a rope until the boom intersects the surface of the LNAPL. The rope will be secured at the well head.

LNAPL and leachate recovered during these tests will be containerized in 55-gallon drums and managed as described in Section 8 of this FSP.

Following completion of the recovery test, the temporary piezometers will be decommissioned as described in Section 2.2.5 of the FSP.

2.2.5 Temporary Piezometer Decommissioning

Following completion of the LNAPL bail-down tests, the temporary piezometers will be decommissioned by removing the PVC casing. The casing will be cut into small pieces and placed in appropriate containers and managed as described in Section 8 of this FSP. The resulting boreholes will be grouted to the ground surface using a cement bentonite grout.

2.3 GROUNDWATER INVESTIGATION

The 13 existing monitoring wells (MW-A through MW-M) were installed at part of the 1984 Consent Decree. It appears that most of the monitoring wells have been installed in filled and capped areas of the site. Well logs are not available for these monitoring wells. The existing monitoring well configuration does not provide an evaluation of groundwater, but rather the leachate in fill material. The existing wells are acceptable for measuring gradients of liquids in the fill. However, the existing well system does not evaluate groundwater quality and quantity beneath and adjacent to the site.

The objectives of the groundwater investigation will be to evaluate the vertical and lateral extent of groundwater and the site's hydrogeological properties. In particular, the characteristics of soils underlying the fill and occurrence of groundwater need to be assessed. In order to evaluate groundwater conditions, the following tasks will be completed:

- Install six shallow monitoring wells and six deep monitoring wells to investigate conditions in areas outside of the capped areas. Three shallow and three deep wells will be nested. The shallow wells will be installed to an estimated depth of 15 ft bgs. The deep wells will be installed to an estimated depth of 30 ft bgs.
- The deep wells will be set through surface casing to isolate the wells from fill leachate and prevent vertical migration;
- All wells will be constructed of 2-inch PVC risers and screens;
- Collect groundwater sampling from new and existing wells;
- Measure water levels from all new and existing wells;
- Perform continuous sampling in order to describe the fill and material soils;
- Perform laboratory hydraulic conductivity testing of soil samples that will be collected using six Shelby tubes pushed into native underlying soils;
- Perform hydraulic conductivity testing (rising head slug tests) on natural water-bearing zones to evaluate formation yields;
- Collect weekly water level measurements from all wells and the Trenton Channel for a period of three months;
- Survey horizontal and vertical locations of all wells;
- Collect leachate samples from below the water table, three Geoprobe borings located adjacent to the Trenton Channel; and
- Collect leachate samples from below the water table on both sides of the bentonite slurry wall (described in Section 2.5).

2.3.1 Borehole Drilling

URSGWC will drill 12 exploratory soil borings that will be converted to monitoring wells. As shown on Figure 2-1, the borings to be converted to monitoring wells will be drilled outside of the capped area. Six shallow borings (SMW-1 through SMW-6) will be drilled to the base of the fill material, an anticipated depth of 10 to 15 feet bgs. These borings will be converted to single-cased groundwater monitoring wells. Six deep borings (DMW-1 through DMW-6) will be drilled through the Peat Layer, the Native Sand Unit, the brown silty clay, and into the gray clay till (an anticipated depth of 30-ft bgs). These borings will be completed as double-cased monitoring wells to prevent the downward migration of leachate into groundwater.

The six shallow borings will be drilled with 4.25-inch ID HSA since they will be converted to 2-inch diameter wells. The six deep borings will initially be drilled using 12.25 in. ID HSA, through the fill and brown silty clay, to a depth of approximately 20 ft bgs.

During drilling of the six deep and three shallow unnested wells, soil samples will be collected continuously to the termination depth. Soil samples will be collected using a split-spoon sampler in general accordance with ASTM D-1586. Split-spoon samples will not be collected during the drilling of the three shallow nested wells since the soils were described in the adjacent deep well. Existing facility information suggests that leachate is present in the fill material at a depth of 6 to 10 ft bgs. The depth to groundwater in the natural soil is not known, at this time.

The soil type, relative moisture content and other pertinent observations will be logged by the URSGWC per USGS protocol on-site representative at the time of drilling. Upon collection, each split-spoon will be opened, logged, sampled, and field screened by URSGWC's on-site representative. Each sample will be divided lengthwise upon retrieval. A portion of the sample will be placed in a separate clean container and used for field screening using a FID or PID. No soil samples will be retained for chemical analysis.

Headspace analysis will be used to field screen soil samples for volatile organic compounds. Soil samples subjected to headspace screening will be held at ambient temperature and exposed to ambient temperatures for at least 10 minutes. The probe of an FID or PID will then be inserted into the sample container. The maximum total organic vapor concentration observed with this procedure will be recorded as the headspace value for that sample. The headspace reading will be recorded in the field book by the URSGWC representative.

Decontamination water generated during these tests will be containerized in 55-gallon drums and managed as described in Section 8 of this FSP. Soil will be staged on Site or placed in a roll-off box as directed by BASF representatives.

2.3.2 Shelby Tube Collection and Analysis

A Shelby tube will be collected from each of the six deep borings being drilled for the installation of the deep monitoring wells. It is anticipated that all six of the Shelby tubes will be collected in the gray clay till. The Shelby Tubes will be collected in general accordance with ASTM D-1587. The tubes will be hydraulically advanced, turned one-half revolution and retrieved. The tubes will then be capped at both ends with plastic caps and sealed with wax. The tubes will remain vertical during shipment and will be submitted to URSGWC's geotechnical laboratory in Solon, Ohio for the following analysis:

- Grain size;
- Atterberg Limits;
- USCS classification;

- Dry bulk density;
- Specific gravity;
- Moisture content;
- Total porosity;
- Volumetric air content;
- Volumetric water content; and
- Saturated vertical hydraulic conductivity.

If a Shelby Tube cannot be successfully extracted because of soil conditions (non-cohesive material or soil) a representative sample will be collected from one of the split-spoons extracted for analytical sampling. In this case, geotechnical properties will be based on soil classification.

2.3.3 Shallow Monitoring Well Installation

The six shallow soil borings will be completed as groundwater monitoring wells. The wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC casing, terminating in a 5- to 10-ft screened section (0.010-inch slotted). A bottom plug will also be installed. A sand pack will be placed in the annular space surrounding the screened section and will extend approximately 1 ft above the screened interval. All well materials will be installed through the hollow-stem augers. A 3-ft-thick bentonite pellet seal will be placed above the sand pack and a bentonite cement slurry will be placed in the remaining space above the seal. A watertight well cap will be placed on all wells to prevent tampering. An above ground locking steel casing will be installed over each groundwater monitoring well. The steel casing will be set in a concrete pad. A typical single-cased monitoring well construction is presented in Figure 2-2.

The horizontal locations and elevation of the top of casings of all shallow monitoring wells will be surveyed by a local professional surveyor.

2.3.4 Double-Cased Well Installation

The six deep monitoring wells will initially be drilled using 12.25 in. ID HSA, through the fill material, the Native Sand Unit (or Peat Unit) and the brown silty clay, to a depth of approximately 20-ft bgs. A cement-bentonite grout mixture will be pumped into the augers and a 20-ft section of 10-in. diameter steel casing will be installed through the augers and seated by hydraulically pushing into the soil gray clay till. The grout mixture will be comprised of an approximate water, cement, and bentonite ratio of 7:15:1 by weight. The annular space between the casing and the borehole will be filled with a cement-bentonite grout using a tremie pipe as the augers are withdrawn. The grout will be allowed to cure for a minimum of 24 hours. After the grout has cured, the boring will advanced through the casing using 4.25-in. ID HSA into the gray clay till to a depth of approximately 10 ft below the bottom of the steel casing.

The deep wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC casing, terminating in a 5-ft screened section (0.010-inch slotted). A bottom plug will also be installed. A sand pack will be placed in the annular space surrounding the screened section and will extend approximately 1 ft above the screened interval. All well materials will be installed through the hollow-stem augers. A minimum 3-ft-thick bentonite pellet seal will be placed above the sand pack and extend above the bottom of the steel outer casing. The remaining annular space will be filled with a bentonite cement slurry. A locking water tight well cap will be placed on all wells to prevent tampering. An above ground locking steel casing will be installed over each groundwater monitoring well. The protective casing will be set in a concrete pad. A typical double-cased monitoring well construction is presented in Figure 2-3.

The horizontal locations an elevation of the top of casings of all deep monitoring wells will be surveyed by a local professional surveyor.

2.3.5 Monitoring Well Development

The newly-installed monitoring wells will be developed after installation to remove silts or fine sands that may have accumulated in the well screen during drilling and installation procedures. The wells will be developed using single use high-density polyethene (HDPE) bailers.

A minimum of 3 well casing volumes of water will be removed from each well or until the well runs dry during development. All water and sediments removed during development will be collected, containerized, and characterized in 55-gallon drums and managed as described in Section 8 of this FSP.

2.3.6 Water Level Measurements

Static water level and the total depth of existing and newly installed monitoring wells will be measured and recorded in the field book prior to purging each well. Static water level and total depth measurements will be made from the top of the PVC riser to the nearest 0.01-foot. The measuring point for all the wells will be northern edge of the top of the well casing. The well conditions (e.g., casing, well pad, protective casing) will also be observed and documented.

Trenton Channel stage measurements will also be collected to evaluate the relationship between the river and leachate and groundwater and beneath the site. River stage readings will be made by referencing the US Army Corp of Engineers (USACE) gauging station at Wyandotte. BASF representatives estimate that the river stage at Riverview is 0.2 ft below the elevation at the Wyandotte USACE station. The USACE collects these readings at one-hour increments to the one-one hundredth of a foot.

2.3.7 Well Purging

The purpose of well purging is to remove the required amount of water from the well to obtain a representative water sample from the geologic formation. A dedicated low-flow (less than 1 liter/min) bladder pump or peristaltic pump will be used to minimize the disturbance of the samples while purging.

The following procedures will be performed at each well:

- The condition of the outer well casing, concrete well pad, protective posts (if present), and any unusual conditions of the area around the well will be noted in the field logbook.

- The well will be opened and the air in breathing zone around the well will be monitored for VOCs with a PID or FID.
- The condition of the inner well cap and casing will be noted.
- The depth of static water level will be measured (to nearest 0.01 foot) and recorded from the measuring point on the well casing that has been surveyed, and the time.
- The purge rate from the dedicated pump will begin at 0.5 L/min, but will be adjusted to avoid allowing the water level in the casing to drop more than 3 inches.
- After purging one casing volume, samples from purge water will be collected to monitor the stabilization of water chemistry. The water chemistry will be considered stable when consecutive readings of field parameters fall within the following acceptable guidelines: pH ±0.25, temperature ± 0.5°C, and conductivity ± 50 µmhos/cm. Purging will continue until the water chemistry is considered stable.

The pH and conductivity meters will be calibrated daily prior to use. Calibration times and readings will be recorded in the field book.

2.3.8 Well Sampling

Samples for chemical analysis will be collected immediately after the water chemistry is considered stable. The pump rate for sample collection will be 0.1 L/min. The individual sample bottles should be filled in the following order:

- Volatile organic compounds (VOCs), if any
- Semivolatile organic compounds (SVOCs), if any
- Metals
- Field test parameters (pH, specific conductance, dissolved oxygen, redox potential and temperature).

Groundwater samples will be analyzed for parameters included in the original consent decree and parameters that were detected in excess of MDEQ GSI standards during the March 1999 groundwater sampling event. Parameters detected in excess of MDEQ GSI standards in samples collected by MDEQ or split samples collected by BASF are included in the program. Groundwater samples will be analyzed for the following parameters:

Fraction / Analyte	USEPA Test Method
Metals (total)	
Arsenic Chromium (total) Lead	6010
Mercury	7000

Fraction / Analyte	USEPA Test Method
Inorganics	
Ammonia	350.1
Cyanide	9012
PCBs	
PCBs (MW-B only)	8082
Base-Neutral Acids	
Benzo(a)pyrene Phenanthrene Naphthalene Pentachlorophenol Acenaphthene 2,4-dimethylphenol Fluorene Bis(2-ethylhexyl)phthalate 2-methylphenol Phenol	8270
VOCs	
Acetone Xylenes Methylene Chloride Vinyl Chloride	8260

Other field parameters recorded will be Dissolved Oxygen (DO) and Oxygen-reduction Potential (Redox). These parameters will be recorded only to support decisions regarding potential remedial activities.

Sample volumes and sample preservatives are specified in the QAPP. In general, two 40-milliliter (ml) laboratory-supplied, hydrochloric acid-preserved, volatile analysis (VOA) vials will be filled for each VOC sample. VOA vials will be completely filled so the water forms a convex meniscus at the top and then capped so that no air space exists in the vial. The vial will be turned over and tapped to check for air bubbles in the vial. If air bubbles are observed in the sample vial, the procedure will be repeated until no air bubbles are present. One unpreserved amber liter will be filled for SVOC analysis. At MW-B, an additional unpreserved amber liter will be collected for PCB analysis. The groundwater samples for metals analysis will be placed in 2, 500-ml plastic bottles (or a one liter plastic container) preserved with nitric acid.

As requested by BASF, additional sample volumes will be collected to analyze for geochemical parameters that may support selection of a potential remedial strategy. Groundwater samples collected from selected well will be analyzed for geochemical parameters in order to evaluate the potential for natural attenuation. The following parameters will be measured using field meters:

Field Analyses

- Dissolved Oxygen
- Redox Potential
- pH

The following parameters will be evaluated by the BASF Inorganic Laboratory in Wyandotte, Michigan:

Laboratory Analyses

- Carbon dioxide
- Nitrate
- Phosphate
- Methane
- Sulfate
- Total Iron
- Reduced Iron (Ferrous)
- Chloride
- Alkalinity
- Hardness

All samples submitted to BASF will be placed in the appropriate containers and preserved as requested by the laboratory.

Twenty-five samples will be collected from the 12 new shallow and deep monitoring wells and 13 existing monitoring wells for the metals, VOC, SVOC and ammonia, cyanide analyses presented above. MW-M and MW-F will only be sampled if LNAPL is not present. In addition, the groundwater sample collected from MW-B will be analyzed for PCBs. Details on analytical methods are provided in the QAPP.

2.3.9 Field Hydraulic Conductivity

The hydraulic conductivity of the groundwater aquifer at the site will be evaluated. In order to estimate the hydraulic conductivity of the native soil, rising head slug tests will be preformed on monitoring wells DMW-1 through DMW-6. If the water rises above the screened interval, falling head slug tests will also be performed. Slug tests will be performed using a Hermit 1000C data logger and a 10-psi pressure transducer.

Rising head tests will be performed by the following procedure. The depth to water will be measured in the well. The transducer will be then lowered by its connecting cord to approximately 1 ft from the bottom of the well and connected to the data logger. A clean, 2-inch HDPE bailer will then lowered into the well casing and secured below the top of the water column. After the water level had returned to equilibrium, the bailer will be removed from the well producing an instantaneous change in the water level (drawdown). As the water level in the well returns to equilibrium, changes in the water level will be detected by the pressure transducer and recorded by the data logger.

2.3.10 Geoprobe Water Sampling

Five (5) leachate samples will be collected from the Geoprobe borings described in this section. The samples will be analyzed for the metals, VOC, BNA ammonia and cyanide analyses presented in Section 2.3.8 of this FSP. Details on analytical methods are provided in the QAPP.

In order to evaluate groundwater quality in the native soil adjacent to the Trenton Channel, three soil borings will be advanced using a Geoprobe® direct push method. The boreholes will be advanced using Geoprobe®'s 2.125-inch Macro Core Sampler with a non-retrievable tip. It is anticipated that the Geoprobe boreholes will be advanced into below the water table. After reaching the appropriate depth of the boring, the tip of the drive rod will be release. Leachate samples will be retrieved through the rods with a 1-inch diameter HDPE bailer.

As described in Section 2.5 of this Plan, the location of the slurry wall will be investigated. Two geoprobe soil borings will be advanced near the slurry wall; one on the east side and one on the west wide of the wall. The borings will be advanced into the fill material and leachate sample will be collected to evaluate conditions on both sides of the slurry wall.

Following collection of the groundwater samples from the Geoprobe borings, the boreholes will be filled to ground surface with a cement bentonite grout or granular bentonite.

2.4 EVALUATION OF EXISTING CLAY CAPS

As illustrated on Figure 2-1, two areas of the site have been reportedly capped with clay. The capped areas encompass approximately 10 acres of the 30-acre site. The caps reportedly consist of approximately 24 inches of clay or six inches of topsoil. The following tasks will be completed in order to evaluate the integrity of the cap and thickness of fill material outside the capped areas:

- Drill 28 shallow soil borings to a depth of 5 feet bgs;
- Perform continuous soil sampling;
- Advance 18 of the cap borings with a Geoprobe;
- Advance 10 cap borings with a conventional drilling rig to collect Shelby tube samples for geotechnical testing;
- Install 14 temporary PVC gas probes to measure gas pressure, CO2, O2 and methane;
- Upon completion of drilling, backfill boring locations with a bentonite/cement grout; and
- Survey horizontal locations of all borings.

2.4.1 CAP Borings

Twenty-eight soil borings will be advanced to evaluate the cap and uncapped fill areas. Eighteen of the borings will be advanced using Geoprobe direct-push methods. The remaining 10 will be advanced using conventional drilling techniques so that Shelby tube can be collected for geotechnical analysis. All 28 borings will be advanced to an anticipated depth of 5 ft bgs.

The soil type, moisture content and other pertinent observations will be logged by the URSGWC on-site representative at the time of drilling. Upon collection, each split-spoon or acetate sleeve will be opened, logged, sampled, and field screened by URSGWC's on-site representative. Each sample will be divided lengthwise upon retrieval. A portion of the sample will be placed in a separate clean container and used for field screening using an FID or PID. No soil samples will be retained for chemical analysis.

Headspace analysis will be used to field screen soil samples for volatile organic compounds. Soil samples subjected to headspace screening will be held at ambient temperature and exposed to ambient temperatures for at least 10 minutes. The probe of an FID or PID will then be inserted into the sample container. The maximum total organic vapor concentration observed with this procedure will be recorded as the headspace value for that sample. The headspace reading will be recorded in the field book by the URSGWC representative.

All cap borings will be grouted to ground surface with a cement bentonite grout. Soil and decontamination water generated during these the drilling of these borings will be containerized in 55-gallon drums and managed as described in Section 8 of this FSP.

The horizontal and vertical location of all cap borings will be surveyed by a local professional surveyor.

2.4.1.1 Conventional Drilling and Shelby Tube Collection

Ten of the cap borings will be drilled with 4.25-inch ID (HSA) so that Shelby tubes can be collected. Soil samples will be logged and described as discussed in Section 2.4.1. The Shelby tubes will be collected for geotechnical analysis, as described below. The 10 borings for geotechnical analysis will be distributed spatially to evaluate the extent and composition of the caps and the fill material. As shown on Figure 2-1, the Shelby tubes will be collected from the following 10 cap borings: CAP-1, CAP-8, CAP-11, CAP-13, CAP-14, CAP-16, CAP-20, CAP-22, CAP-23, and CAP-27.

In areas were the clay cap is present, the Shelby tube will be collected from the clay. In areas where the clay cap is not present, the Shelby tubes will be collected from the fill material.

The Shelby tubes will be collected in general accordance with ASTM D-1587. The tubes will be hydraulically advanced, turned one-half revolution and retrieved. The tubes will then be capped at both ends with plastic caps and sealed with wax. The tubes will remain vertical during shipment and will be submitted to URSGWC's geotechnical laboratory in Solon, Ohio for the following analysis:

- Grain size;
- Atterberg Limits;
- USCS classification;
- Dry bulk density;
- Specific gravity;

- Moisture content;
- Total porosity;
- Volumetric air content;
- Volumetric water content; and
- Saturated vertical hydraulic conductivity.

If a Shelby tube cannot be successfully extracted because of soil conditions (non-cohesive material or soil) a representative sample will be collected from one of the split spoons extracted for analytical sampling. In this case, geotechnical properties will be based on soil classification.

2.4.1.2 Geoprobe CAP Borings

Eighteen cap borings will be advanced using the Geoprobe® direct push dual tube sampling system. Boreholes will be advanced using Geoprobe®'s 2.125 inch diameter dual tube system that consists of a steel outer casing and inner acetate sampling sleeve. Soil samples will be logged and described as discussed in Section 2.4.1.

2.4.2 Vapor Probes and Soil Gas Sampling

Soil-vapor probes will be installed in 14 of the 18 cap borings advanced by the Geoprobe. A five foot section of 1-inch diameter PVC will be placed in the borings. The bottom 2 to 3 feet of the probe will be slotted. Sand will be installed in the annular space to top of the slots. A minimum 1-ft thick bentonite seal will be installed above the sand pack. A slip cap will be placed over the top of the PVC probes. Prior to sampling the wells, ambient air will be purged by placing slip cap with a quick-connect to an electric vacuum pump. Field measurements of methane, CO2 and O2 will be measured with appropriate, calibrated field meters. Two separate readings will be collected from the soil-vapor probes. The first will be collected a minimum of 8 hours after installation. The second will be collected near the end of the field sampling program.

The PVC will be removed following collection of the second round of readings. The 14 cap borings will then be grouted to ground surface with a cement-bentonite grout.

2.5 BENTONITE SLURRY WALL EVALUATION

Available information indicates that FMT began construction of a bentonite slurry wall near the Detroit River. BASF believes that the wall extends approximately 350 feet southward from the northeast corner of the property. URSGWC completed a review of BASF files, no additional information was available concerning the slurry wall. In order to evaluate the location of the slurry wall, the following activities are proposed:

- Excavate two shallow (0-5 ft bgs) trenches that extend perpendicular to the fenceline. The trenches will extend until the wall is encountered. They will have a maximum anticipated length of 100 ft. An attempt will be made to not disturb the wall;
- After the location of the wall has been established with the two trenches, additional smaller test pits will be excavated to further evaluate the wall;

- Upon completion the trenches will be backfilled with spoils removed; and
- Survey the horizontal and vertical location of the slurry wall.

The purpose of this work will be to identify the location of the wall, so if future remedial actions can either supplement or tie-in to this structure its location is identified. The proposed location of the trenches are presented on Figure 2-1. The trenches will be excavated with a backhoe, or trackhoe, based on equipment availability and site conditions.

Excavated soil will be staged on the ground surface adjacent to the trenches. Upon completion of the excavations, they will be backfilled with the excavation spoils. It is not anticipated that the trenches will remain open for more than 3 days. No worker will enter the trenches unless proper precautions have been taken.

The sampling activities will include the collection and analysis of field duplicates, field blanks, trip blanks, and matrix spike/matrix spike duplicate (MS/MSD) samples. The Quality Assurance/Quality Control QA/QC samples will be collected with the frequencies summarized below:

- Field duplicates – one per 10 leachate or groundwater samples per each media
- Trip blanks - one per cooler containing VOC samples
- Matrix spike/matrix spike duplicates (MS/MSDs) – one per 20 samples for each analytical method

The sections below summarize the purpose of these QA/QC samples and outlines the procedures for collecting and handling the QA/QC samples. QA/QC procedures are discussed in detail in the QAPP (Appendix B).

3.1 FIELD DUPLICATES

Field duplicate samples will be used to provide an estimate of the aggregate sampling and analytical precision. The duplicate samples will be collected, handled, transported, and analyzed in the same manner as the samples that they duplicate.

3.2 TRIP BLANKS

Trip blanks are used to determine whether contaminants may have been introduced during the sample shipping process. The trip blank will be prepared by the contract laboratory and transported to the site with the sample containers. A trip blank sample will accompany each cooler of VOC samples. Trip blanks will remain in the coolers as samples are collected and stored. They will be labeled, documented, and packaged in the same manner used for samples collected during the sampling event and shipped back to the laboratory in the coolers with the collected VOC samples.

3.3 MATRIX SPIKES/MATRIX SPIKE DUPLICATES

MS/MSD samples are environmental samples to which the same known concentrations of analytes have been added. The MS/MSD samples are used to evaluate the effect of the sample matrix on the precision and accuracy of the analysis. The MS/MSD samples will be collected at three times the volume normally collected to provide adequate sample volume for the laboratory. They will be handled and transported in the same manner as similar samples collected during the sampling event.

The subsections below outline the system that will be used to label sample locations and samples.

4.1 WELL, PIEZOMETER, AND BORING LOCATION DESIGNATIONS

In order to facilitate data storage and retrieval, the monitoring wells, soil borings, and Geoprobe boring will be assigned unique location designations. The existing monitoring wells are designated with letters A though M. The new monitoring wells will be designated with a "SMW" for shallow wells completed in the fill. The deep wells completed in the native soil will be designated with a "DMW". The shallow and deep monitoring wells will be numbered 1 through 6.

The six soil borings will be designated as "DB" for deep boring and "SB" for shallow boring. The deep borings will be numbered DB-1 through DB-3. The shallow borings will be numbered SB-1 through SB-3. The three Geoprobe sampling locations will be designated with a "GP". They will be numbered with as GP-1 through GP-3. The cap investigation samples will be designated by "CAP". These locations will be numbered CAP-1 through CAP-28.

4.2 SAMPLE NUMBERING

A sample numbering system will be issued for identifying and tracking analytical samples. Each sample collected will be assigned a unique sample identification number. The sample identification number will consist of four parts:

- Groundwater samples collected will be designated by their sample locations:
  - SMW – Shallow monitoring well
  - DMW- Deep monitoring well
  - GP – Geoprobe sample
- A one or two digit sample location number following the location code.
- An additional modifier will be added for quality assurance/quality control samples.
  - MS – Matrix spike/matrix spike duplicate sample
  - Trip – Trip blank sample
- As discussed in the QAPP, blind duplicate samples will be submitted to the laboratory. Duplicate samples will be designated by adding a zero to a sample number.
- A date designation code will be will indicate the month and year the water sample is collected.

Examples of a sample identification numbers are as follows:

- DMW-6-7-99 - This label identifies a groundwater sample that was collected from DMW-6 in July 1999.
- MW-K-MS-7-99 – This label identifies a matrix spike/matrix spike duplicate sample collected from MW-K in July 1999.
- SMW-50-7-99 - This label identifies a duplicate sample collected from SMW-5 in July 1999.

- Trip 7-1-99 GP-2-BLK-7-99 - This label identifies a trip blank collected on July 1, 1999.

4.2.1 Waste Designations

Drums of solid and liquid waste will be labeled with their date of generation. If samples are submitted for waste characterization, the following designations will be used:

- Drum - Drummed Water
- Waste - Solid Waste

Waste designation examples include:

- Drum-7-8-99 – Drummed water generated from purging, developing or decontamination activities up through July 8, 1999.
- Waste-7-8-99 – Drummed solid waste generated up through July 8, 1999.

4.3 LABELING

Sample labels will be affixed to each sample at the time of collection. The label will include the following information at a minimum:

- Sample identification number
- Date and time sampled
- Preservatives added (as required)
- Sampler's initials
- Analyses required

The above information will be recorded in the field book, as discussed in Section 6.0. Details regarding sample shipment are provided in Section 5.0 of this FSP. Additional details regarding Chain of Custody documentation and other sample analysis details are provided in the QAPP.

All environmental samples, selected for off-site analytical testing, will be shipped by overnight courier, or hand-delivered to Shrader Laboratories Inc. in Detroit, Michigan. Samples will be received by the designated laboratory within 24 hours after sampling to initiate analyses within the specified holding times. Shipping containers will conform with US Department of Transportation (DOT) shipping regulations. Shipping containers (insulated coolers) will be cleaned between shipments to prevent potential cross-contamination.

Samples will be preserved, as required, to retard chemical and biological changes that may occur in response to changes in physical conditions. Sample containers will be sealed after proper preservation. Prior to packing, the openings of all sample containers will be checked for tightness as a measure of additional security.

Glass containers will be wrapped and cushioned in a packing material such as Styrofoam® or bubble wrap. Samples will be placed carefully in coolers for storage and shipment. Ice, sealed in double plastic bags, or frozen blue ice will be placed inside each cooler to maintain a sample temperature near 4°C. A chain-of-custody form will be provided in each shipping container. If a cooler is shipped (not hand delivered) it will be taped shut to form an adequate seal around the lid to prevent leakage. Shipped coolers will include a security seal placed on each shipping container to maintain chain-of-custody protocol.

Samples submitted for geochemical analysis at the BASF Inorganic Laboratory in Wyandotte, Michigan will be packed in the same manner as the environmental samples and hand-delivered to the laboratory.

All field activities will be documented in field books and through photographs. A discussion of the documentation requirements is provided below.

6.1 FIELD BOOKS

Data collected during the EE/CA field activities will be recorded in the field book. Entries will include sufficient detail so that a particular situation can be reconstructed without relying on memory.

Field books will be bound and identified by project numbers. A main site field book will be used at the start of the field activities and individual logbooks will be referenced and recorded in the main book. The main book will include the project name, and the names of personnel at the site.

The title page of each field book will contain the following:

- Name of person or organization to whom the book is assigned
- Book number
- Project name
- Start date
- End date
- Project task number

The beginning of each entry into the field book will contain the date, time, weather, names of all field team members present, and level of personal protection being used. The entries will be completed with the signature of the person making the entry.

Measurements and samples collected will be recorded in the field books. Whenever a sample is collected or a measurement made, a detailed description of the location will be recorded. All equipment used to make measurement will be identified along with the date of calibration where appropriate. Equipment used to collects samples will be noted along with the time of sampling, sample description, depth, volume, and number of containers. Sample identification numbers will be assigned prior to sample collection. Duplicate samples, which receive a separate sample identification number, will be noted.

The names of visitors to the site and the purpose of their visit will be recorded in the field book. Photographs taken will also be noted. All entries will be made in ink. No entries may be erased. If an incorrect entry is made, the information will be crossed out with a single strike, initialed, and dated.

6.2 PHOTOGRAPHS

The picture number, roll number, and direction of all photographs will be documented to identify the sampling location or operation being depicted in the photograph. The film roll number will be identified by taking a photograph of an informational sign of the first frame of the roll. This sign will display the job and film roll number to identify the pictures contained on the roll. If available, a camera with an automatic time-date-stamp will be used.

Decontamination of personnel and equipment will be performed to limit the transport of contaminants to personnel, to off-site areas, and between work areas. Personnel and personal protective equipment (PPE) decontamination protocol is presented in a HASP and summarized below in Section 7.1. All sampling equipment that comes into contact with contaminated media will be decontaminated prior to sampling, between sampling locations, and at the completion of work to minimize the potential for cross-contamination of samples and accumulation of erroneous data. Equipment decontamination procedures are summarized below in Sections 7.2 and 7.3.

7.1 PERSONNEL

Sampling personnel will wear clean PPE prior to obtaining each sample. To minimize the potential for cross-contamination, disposable gloves will be worn by the sampling team and changed between sampling points.

Site personnel will perform personal contamination procedures after completion of tasks, prior to leaving the contaminated area. The personal decontamination procedures are as following:

- Any non-disposable PPE involved with sample acquisition efforts will be decontaminated with a non-phosphate detergent solution wash and distilled water rinse;
- Disposable outer coveralls, booties, and gloves will be removal and disposed;
- Hands and face will be washed; and
- Entire body, including hair, will be showered at the end of work day.

Disposable PPE will be placed into plastic bags and stored on site prior to off-site disposal pending analytical results.

7.2 SMALL EQUIPMENT DECONTAMINATION

Reusable equipment (e.g., water level indicator, split-spoon samplers and stainless steel spoons) will decontaminated prior to initial use, during sampling intervals, and before leaving the site. The equipment will be decontaminated using either (1) a non-phosphate soap wash, potable water rinse, and distilled water rinse or (2) a high-pressure hot water or steam cleaning unit.

Decontamination using a high-pressure hot water or steam cleaning unit will be completed over a temporary decontamination pad. Disposable equipment will be placed into plastic bags and stored on site prior to off-site disposal pending analytical results.

7.3 HEAVY EQUIPMENT DECONTAMINATION

Appropriate parts of the heavy equipment (e.g., excavation equipment and drill rigs) that are in direct contact with potentially contaminated media during drilling and sampling will be decontaminated by steam-cleaning prior to beginning work and leaving the site. Augers and any parts of heavy equipment that have been in direct contact with potentially contaminated media will be steam-cleaned prior to moving to the next location to prevent the possibility of cross-contamination.

The heavy equipment decontamination procedures will consist of brushing or scraping debris from exposed equipment surfaces, as required, followed by high pressure hot water wash/rinse using a steam-cleaning unit. All heavy equipment decontamination will be performed over a temporary decontamination pad.

Single use PPE, sampling equipment and temporary piezometer casings will be containerized in 55-gallon drums or roll-off containers as directed by BASF representatives. Soil cuttings will be placed on the ground or placed in roll-off containers as directed by BASF representatives. All 55-gallon drums will be secured with a locking lid, labeled and stored in a temporary drum storage area on site. The temporary storage area and the drum contents will be noted in the field book. If generator knowledge and the analytical data obtained through the site investigation are not sufficient information for the disposal facility, one composite sample will be analyzed for waste characterization under standard laboratory turnaround time. The waste will be characterized as requested by the disposal facility. The wastes will be removed from the site within 30 days of generation or as quickly as possible using standard laboratory turnaround time.

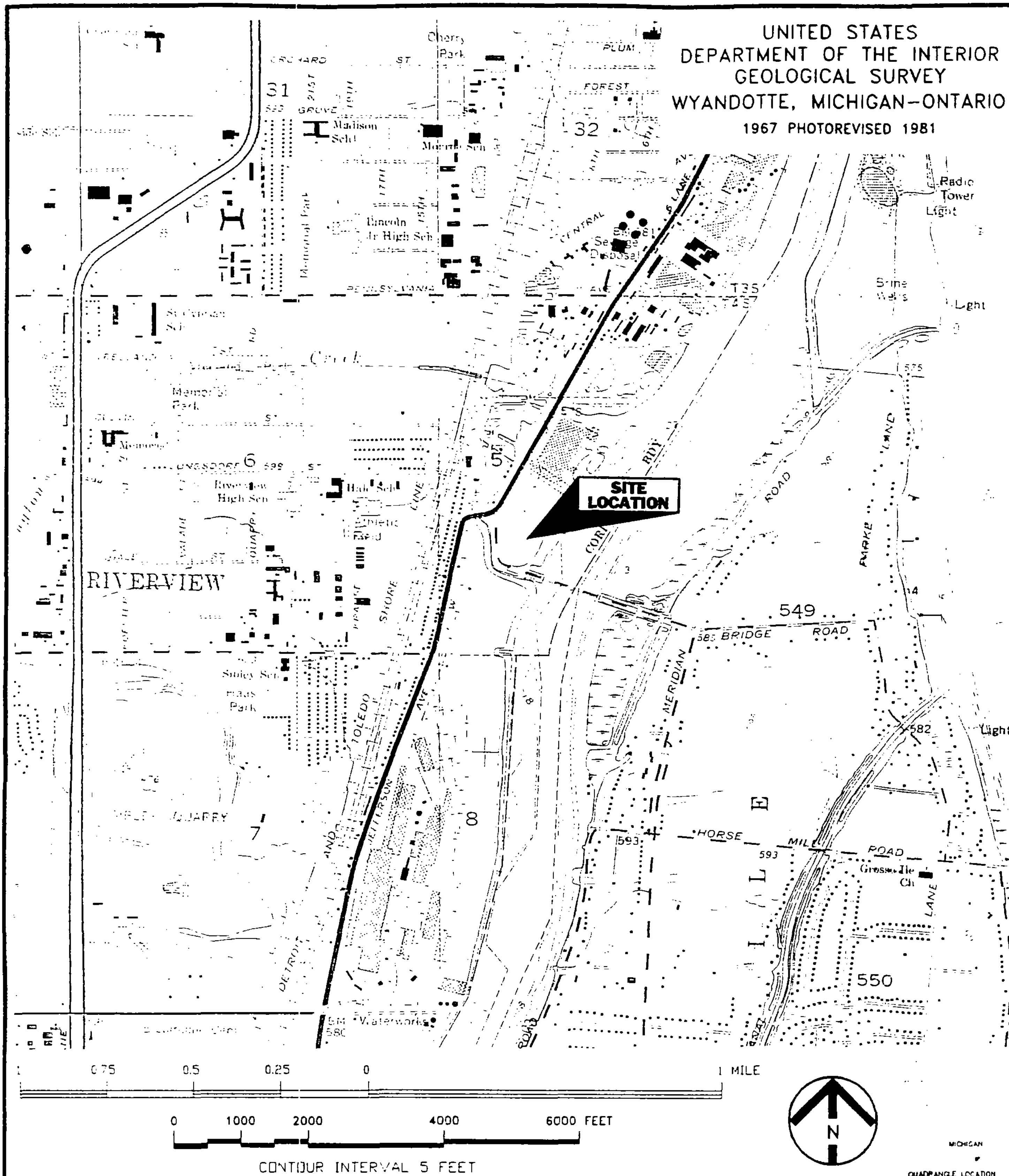
All development and decontamination water will be containerized in 55-gallon drums, secured with a locking lid, labeled, and stored in a temporary drum storage area on site. Purge water will be placed back in the well or piezometer from which it was removed. The temporary storage area and the drum contents will be noted in the field book. If generator knowledge and the analytical data obtained through the site investigation are not sufficient information for the disposal facility, one composite sample will be analyzed for waste characterization under standard laboratory turnaround time. The waste will be characterized as requested by the disposal facility. The wastes will be removed from the site within 30 days of generation or as quickly as possible using standard laboratory turnaround time.

The waste characterization samples will be analyzed using appropriate USEPA analytical methods.

MDEQ is scheduled to collect leachate samples from the existing wells in June 1999, prior to implementation of the EE/CA Work Plan. URSGWC will collect split samples from MDEQ. BASF and URSGWC will determine the analytical suite for the split samples prior to their collection.

A schedule for the overall EE/CA Work Plan is presented in the Work Plan. The schedule shows the anticipated time period to complete the EE/CA field activities. Timing of the individual activities is not shown; however, since timing may vary based upon weather and contractor availability.

The period of time expected for all field activities to be complete is approximately 6 weeks. This may vary based on weather conditions, contractor availability, or issues not apparent until the field activities are started. Preliminary laboratory results can be expected within four weeks of sample collection.



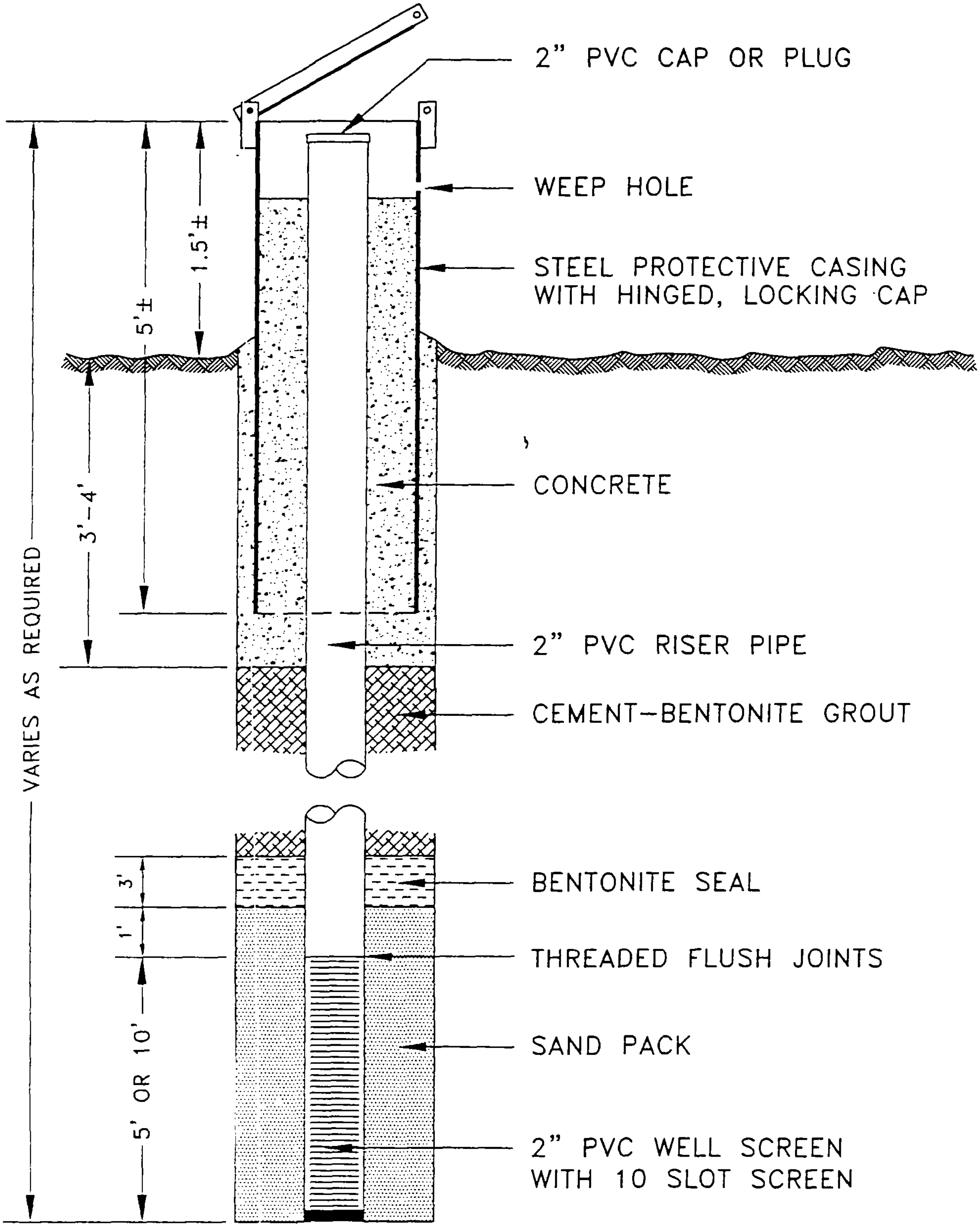
GENERAL LOCATION MAP

BASF PROPERTY - RIVERVIEW, MICHIGAN

DRAWN BY: TBC	CHECKED BY: TLW	PROJECT NUMBER: 8E06216	DATE: 4-18-99	FIGURE NO: 1-1

O:\BASF\8E06216\6216GLM

URS Greiner Woodward Clyde



DRAWING NOT TO SCALE

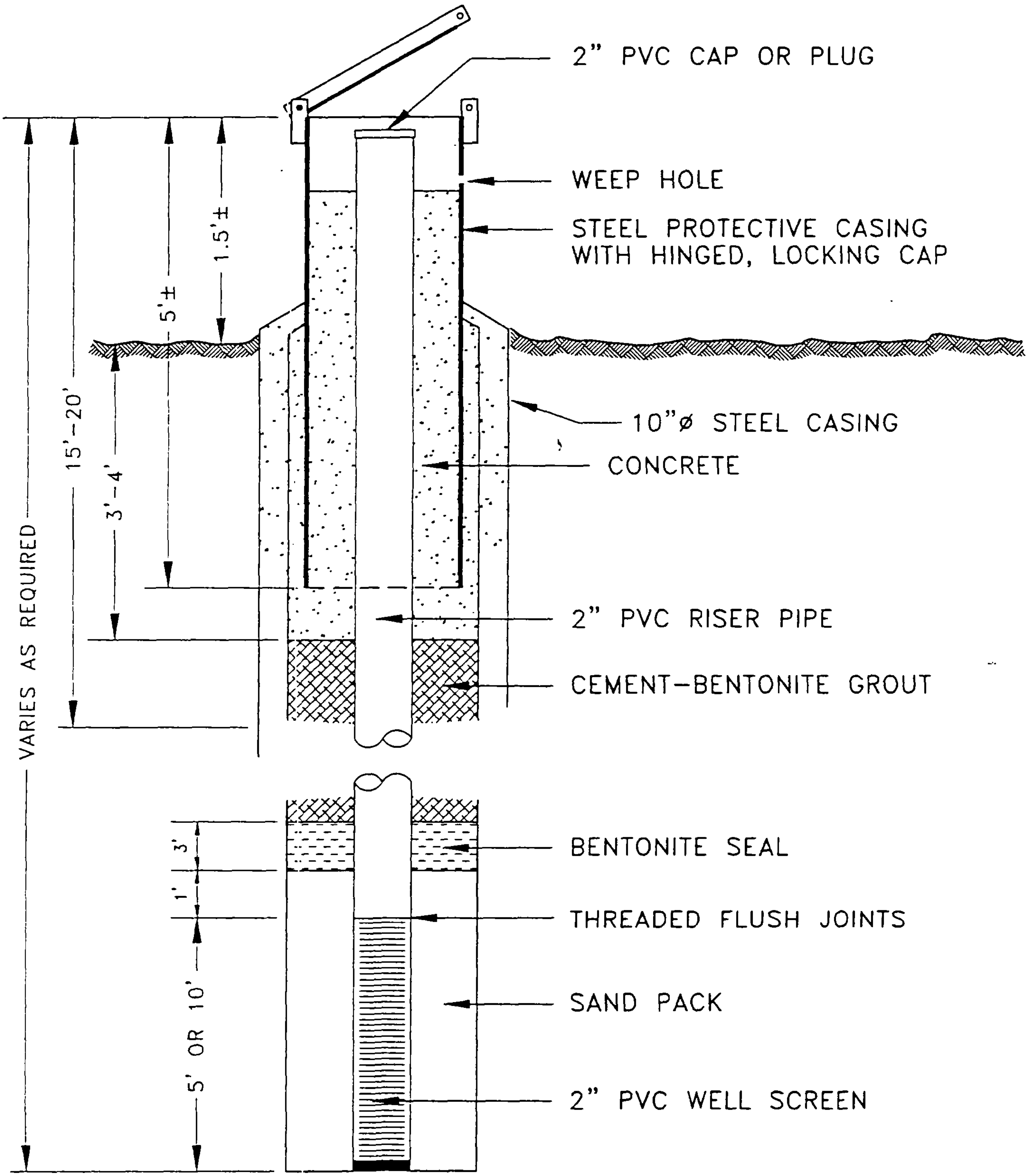
TYPICAL SINGLE CASED MONITORING WELL CONSTRUCTION DIAGRAM

BASF SITE - RIVERVIEW, MICHIGAN

DRAWN BY: MMS	CHECKED BY: MJM	PROJECT NUMBER: 8E06216	DATE: 04-18-99	FIGURE NO: 2-2

URS Greiner Woodward Clyde

G:\BASF\8E06216\WELL1.DWG



DRAWING NOT TO SCALE

TYPICAL DOUBLE-CASED MONITORING WELL CONSTRUCTION DIAGRAM

BASF SITE - RIVERVIEW, MICHIGAN

DRAWN BY: MMS	CHECKED BY: MJM	PROJECT NUMBER: 8E06206	DATE: 04-12-99	FIGURE NO: 2-3

O:\BASF\8E06216\WELL2.DWG

URS Greiner Woodward Clyde

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA)

RIVERVIEW SITE RIVERVIEW, MICHIGAN

Prepared for
BASF Corporation
Wyandotte, Michigan

April 20, 1999

URS Greiner Woodward Clyde
A Division of URS Corporation

30775 Bainbridge Road
Suite 200
Solon, Ohio 44139
(440) 349-2708
Project No. 3808E060216.00

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

1.1 PURPOSE AND OBJECTIVE

URS Greiner Woodward Clyde (URSGWC) is performing an Engineering Evaluation/Cost Analysis (EE/CA) to evaluate environmental conditions at the BASF Corporation Riverview site (Site) located north of the intersection of Jefferson Avenue and Riverside Drive in Riverview, Michigan. The EE/CA will provide sufficient information to the Michigan Department of Environmental Quality (MDEQ) for the selection of remedial alternatives. The response action from the EE/CA will mitigate or eliminate unacceptable risks to human health, welfare and the environment arising from the release or threat of release of hazardous substances, pollutants, or contaminants at and from the Site. The EE/CA will involve a focused investigation of the occurrence of chemicals in the leachate and groundwater underlying the Site.

This Quality Assurance Project Plan (QAPP) presents the policies, organization, objectives, functional activities and specific Quality Assurance (QA) and Quality Control (QC) activities designed to achieve the specific data quality goals associated with the EE/CA to be performed at the Site.

The purpose and objective of the QAPP is to achieve the specific data goals of the project by describing minimum procedures to assure that the precision, accuracy, sensitivity, completeness, comparability, and representativeness of the collected data are known and documented and that analytical results are accurate and representative of field conditions.

The QAPP was prepared following EPA QAMS 005/80-guidance documentation. The QAPP is to be used in conjunction with the EE/CA Work Plan and Field Sampling Plan.

2.1 SITE BACKGROUND

A description of the BASF Riverview site history is presented in Section 2 of the Work Plan.

2.2 SAMPLING PROGRAM OBJECTIVES

The major environmental concern at the Site is potentially contaminated groundwater. Groundwater will, therefore, be the primary focus of the investigation sampling activities.

The overall objective of the sampling program is to evaluate the hydrogeological conditions and groundwater quality at the Site. Additional objectives of the EE/CA Program include:

- Remove oily material found in one monitoring well to ensure that it is not a continuing source of contamination;
- Evaluate the integrity of the caps and their ability to perform the intended function; and
- Formulate recommendations for potential remedial actions or remedial measures to ensure BASF's continued compliance with environmental regulations.

To meet the objectives, data collected during the investigation must be of sufficient quality and quantity to support risk assessment for human health and the environment. The Work Plan describes the rationale for sample collection to achieve the objectives of the EE/CA Program. This QAPP describes the protocols to be followed to ensure that the data collected during the field investigation meets the objectives and quality necessary for its intended use, that is qualitative data requiring vigorous QA/QC for site characterization, risk assessment, and to provide a legally defensible data base.

2.3 PROJECT SCHEDULE

A project schedule is presented in Section 6 of the Work Plan. The beginning date of the scheduled tasks will be determined by the date of submittal of the Draft Work Plan and supporting documents to MDEQ.

The project organization for the Riverview Site EE/CA Program is shown in Figure 3-1. The project organization identifies the hierarchy and individuals involved in the project. Mr. Jack Lanigan, on behalf of BASF Corporation, will be responsible for overall coordination and overseeing of project work activities. BASF has retained URSGWC to perform the EE/CA at the BASF Riverview Site. The roles of each of the key project individuals are described below. Individual assignments to the project organization may be changed at the discretion of the URSGWC Project Manager.

3.1 RESPONSIBILITIES OF KEY PERSONNEL

3.1.1 Project Manager: Keith Mast, P.E.

The Project Manager has overall responsibility for activities on the project and monitoring the Site Assessment Managers' activities. The Project Manager has overall responsibility for the development of the Work Plan and supporting documents, for monitoring the quality of the technical and managerial aspects of the project, and for implementing the scope of work, and (where necessary) corrective measures. The Project Manager will also assist the Site Assessment Managers in interactions with BASF and MDEQ's representative on regulatory and technical issues.

3.1.2 Site Assessment Managers: Martin Schmidt, Ph.D. and Timothy Whipple, CHMM

The Site Assessment Managers report directly to the Project Manager. The Site Assessment Managers have primary responsibility for the completion of all activities on the project. The Site Assessment Managers are responsible to the Project Manager for the day-to-day control of planning, scheduling, cost control, and implementation of the project, and for the development of the Work Plan, supporting documents and other technical reports and project documents. The Site Assessment Managers monitor all project personnel in planning and coordinating all technical aspects of the tasks.

3.1.3 Quality Assurance Officer: Anthony J. Misercola

The Quality Assurance Officer (QAO) reports to the Project Manager and works directly with the Site Assessment Managers and other project personnel. The QAO has the responsibility to develop site-specific quality assurance plans, as well as to monitor and verify that the work is performed in accordance with the QAPP and other applicable procedures. The QAO also has the responsibility to assess the effectiveness of the QA/QC program and to recommend modifications to the program as applicable.

The QAO monitors that personnel assigned to the project are trained and demonstrate an understanding of the requirements of the QA/QC program. The QAO is also responsible for reviewing and verifying the disposition of nonconformance and corrective action reports, and for periodic QA audits (field, laboratory, sampling audits). The QAO will advise the Site Assessment Managers on implementation of the QA/QC program; however, the functions of the QAO are independent of the Site Assessment Managers. The QAO is responsible for the coordination with the subcontracted analytical laboratory and resolving problems. The QAO will be responsible for the development of a project-specific data usability report. The QAO will approve the QAPP and all revisions to the QAPP. The QAO has the authority to halt work in case of major problems or nonconformances to the QAPP, or if numerous minor problems are not corrected in a timely manner.

3.1.4 Site Health and Safety Officer: Daniel Fousek

The Site Health and Safety Officer monitors all site activities and is responsible for the implementation of the Site Health and Safety Plan. The Site Health and Safety Officer works with the Site Assessment Managers to ensure overall compliance with the Health and Safety Plan. A detailed description of the responsibilities of the Site Health and Safety Officer is presented in the Health and Safety Plan.

3.1.5 Field Investigation Leaders: Hosam Hassanien, CPG and Clifford Yantz

The Field Investigation Leaders are appointed by the Site Assessment Managers and will be responsible for coordinating all field activities. The Field Investigation Leaders are responsible for scheduling and overseeing contractors such as drillers and other project staff. The Field Investigation Leaders will also work with the Quality Assurance Officer to accomplish the objectives of all aspects of the Work Plan and supporting documents including this QAPP, as they pertain to the field activities.

3.1.6 Senior Peer Review: John Seymour, P.E.

Peer reviews will be conducted by senior URSGWC personnel on an ongoing, interactive basis, to provide assurance that the quality of services is in accordance with the standards of the profession, and to ensure that the project objectives are pursued. Peer reviews will be completed prior to submission of the results of work or technical recommendations to BASF. Upon completion of a peer review, the Peer Reviewer will discuss their comments with the author/originator and any significant issues concerning the quality of the work reviewed will be resolved. The peer review process will be documented in writing through use of a Peer Review Documentation form. At the discretion of the Project Manager, other qualified professionals may be designated as peer reviewers.

3.1.7 Subcontractor Services

Implementation of the Work Plan and supporting documents will require subcontractors for providing additional project support for services such as:

- Drilling services for Geoprobe® sampling and monitoring well installation
- Off-site commercial laboratory chemical analyses of groundwater samples

All subcontractors will be required to hold appropriate licenses and insurance certifications for work they are assigned.

3.1.8 Qualifications of Personnel

Personnel assigned to the project, including subcontractors, shall be qualified to perform the tasks to which they are assigned.

The Site Assessment Managers shall make evaluation of the qualifications of technical personnel assigned to the project. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee. It will also include a determination whether further training is required and, if required, by what method. On-the-job training is acceptable, when training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented.

Training and qualifications of subcontractor personnel is assured through certifications and licenses issued by regulatory agencies. Drilling services will be provided by a Michigan licensed driller. Surveying will be provided by a Michigan licensed surveyor. Off-site commercial laboratory analytical services will be provided by Shrader Analytical & Consulting Laboratories (Shrader) of Detroit, Michigan. Michigan currently does not have licensing requirements for analytical laboratories.

4.1 GENERAL

The overall QA objective for the EE/CA Program at the BASF Riverview Site is to develop and implement procedures for sampling, laboratory analyses, field measurements, and reporting that will provide data having a degree of quality consistent with its intended use. The sample set, chemical analytical results, and interpretations must be based on data that meet or exceed quality assurance objectives established for the project. Quality assurance objectives and procedures for field measurement systems are also important aspects of these investigations. The following paragraphs discuss field and laboratory analytical measurements.

Quality assurance objectives are usually expressed in terms of accuracy or bias, precision, completeness, representativeness, comparability, and sensitivity of analysis. Target ranges for these objectives are presented for analytical testing and field measurements. Variances from the quality assurance objectives in any stage of the project will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process.

4.2 LEVEL OF QA EFFORT

4.2.1 Field QC Samples

To assess the quality of data resulting from the field sampling program, field QC samples such as field duplicates, matrix spike/matrix spike duplicate (MS/MSD) samples, and trip blank samples will be collected and submitted, where appropriate, to the laboratory.

The frequencies of field QC samples that will be collected and submitted for analyses are as follows:

i) <u>Groundwater samples</u>

- One field duplicate sample will be collected for each 10 investigative samples.
- Trip blank samples will be submitted to the laboratory at a rate of one per shipment (cooler) of groundwater samples collected for VOC analyses.
- Sufficient sample volume will be collected and supplied to the laboratory to perform one MS/MSD sample analyses for each 20 investigative groundwater samples.

Field duplicate samples will be analyzed to check the aggregate sampling and analytical precision. Trip blanks will be analyzed to check for contamination resulting from sample shipping activities. MS/MSD samples will be analyzed to evaluate analytical accuracy and precision. Field rinsate blank samples will not be collected since all sampling equipment will be disposable between each well.

The sampling and analysis plan is summarized in Table 4-1, which lists the specific parameters to be measured, the number of samples and the specific QC samples required for each matrix.

4.2.2 Laboratory QC Samples

The number and type of QC samples to be performed by the analytical laboratory will be equivalent to the level of QC effort specified by the most recent versions of the USEPA analytical methods being used for analyses.

USEPA approved methodology will be used for off-site commercial laboratory analyses to ensure that the database meets the objectives and quality necessary for its intended use, namely:

- to measure the contaminant distribution and flux
- to provide a legally defensible data base
- to assess, evaluate, or recommend whether corrective measures may be necessary

4.2.3 Field Measurement QC

Other measurement data will be generated during field activities. These activities include, but are not limited to:

- Documenting time and weather conditions
- Measuring pH, specific conductance, temperature, dissolved oxygen, and Redox potential measurements of groundwater samples
- Measuring depths in volumes in wells and piezometers
- Verifying well development and pre-sampling purge volumes
- Observations of drill cuttings, sample appearance and measuring organic vapor content

The general QA objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the use of standardized procedures.

4.3 DATA QUALITY INDICATORS

The quality of sampling and analyses will be assessed using five data quality indicators: (1) accuracy, (2) precision, (3) completeness, (4) representativeness, and (5) comparability. Specific objectives for each of these characteristics are established to assist in the development of sampling protocols, and to identify applicable documentation, sampling handling procedures, and measurement system procedures. The objectives are established based on site conditions, goals of the project, and knowledge of available measurement systems. Data obtained during the investigation are intended to be used to 1) identify any potential releases or suspected releases of hazardous waste or hazardous constituents from the site, 2) assess the hydrogeological conditions and groundwater quality, and 3) to evaluate and recommend whether remedial measures may be necessary.

4.3.1 Accuracy

Accuracy is the measure of the bias in a system and can be defined as the degree of agreement between a measurement and an accepted reference or true value. The accuracy of laboratory analyses will be monitored by the analysis of matrix spike (MS) samples and surrogate spike compounds. The quality assurance objective with respect to accuracy for these analyses is to achieve the QC acceptance criteria of the analytical protocols. Recommended spike recovery control limits for MS compounds/analytes and surrogate compounds as provided by Shrader Laboratories will be used as accuracy objectives. Tables 4-2 and 4-3 provide the accuracy objectives for matrix spike compounds/analytes and surrogate spike compounds as presented by the contracted laboratory.

The accuracy of field measurements will be supported by adherence to the sampling procedures described in the Work Plan and calibration and maintenance of field equipment in accordance with manufacturer's recommendations.

4.3.2 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Analytical precision for laboratory analyses will be determined by the analysis of MS/MSD samples. The measure of precision will be expressed as a relative percent difference (RPD). RPD control limits for MS/MSD analyses as provided by Shrader Laboratories will be used as precision objectives for laboratory analyses. Precision objectives for MS/MSD analyses are provided in Table 4-2.

The precision of field analyses will be supported by adherence to the sampling and analysis procedures described in the Work Plan.

4.3.3 Completeness

Completeness is defined as the percentage of the total measurements which are judged to be valid in accordance with the methods used for analysis. The completeness objective is to generate a sufficient amount of valid data to support decision making for the investigation.

The data set must contain all QC analyses verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals to assess the sufficiency of the database. Completeness is calculated as the number of usable data points divided by the amount of samples analyzed, multiplied by 100. The goal for all measurement systems is 100% completeness, that is, all the data should be valid. This is not always the case. The acceptability of less than 100% complete data will be reviewed on a case-by-case basis. The acceptability will be based largely on the significance of a particular measurement system to the project goals.

4.3.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition.

Representativeness is a qualitative parameter most concerned with the proper design of the sampling program. The representativeness criteria will be satisfied by collecting samples from potentially impacted media at appropriate locations, and by collecting a sufficient number of samples to fulfill program objectives. The rationale used to select representative sampling locations is described in detail in the Work Plan.

Field duplicate samples will be collected and utilized as a means to assess the precision of field sampling, one indicator of representativeness. Representativeness will also be maintained during the sampling effort by performing all sampling in compliance with the procedures described in detail in the Work Plan.

4.3.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data are comparable if siting considerations, collection techniques, measurement procedures/methods, and reporting are equivalent for the samples within a sample set. Data comparability will be assured by the use of standard methods for sample collection and standard procedures for laboratory analyses, as documented in the Work Plan and this QAPP.

4.4 SENSITIVITY OF ANALYSIS

The project target limits (PTLs) are defined as those concentrations that laboratory analytical procedures should achieve to meet project objectives. These PTLs should not be considered "cleanup" criteria at the site but rather laboratory performance criteria.

The PTLs for groundwater to be used for laboratory analyses for this project are in accordance with the Target Detection Limits (TDLs) established by the Michigan Department of Environmental Quality (MDEQ) in ERD Operational Memorandum #6, Revision #5 dated November 16, 1998. The TDLs developed by the MDEQ were established by reviewing the low-level capabilities of available analytical methods and the method detection limit based reporting levels of government and commercial laboratories. The MDEQ then selected those levels that are achievable and available from a reasonable number of laboratories and are below the appropriate land use risk-based cleanup criteria, wherever practical.

The PTLs to be achieved by the laboratory are presented in Table 4-4 and will be attained barring any dilutions required due to sample concentrations or matrix interferences. In cases where dilutions are required due to sample concentrations exceeding the instrument linear calibration range or from matrix interferences, the laboratory will be required to report the results of multiple analyses (i.e. the results of the diluted analysis and at least a 10 times more concentrated analysis). Additionally, during sample analysis, if matrix interferences require that the sample be diluted, then the sample extract will be subjected to one or more of the clean-up techniques cited in the approved USEPA analytical methods, prior to re-analysis in an attempt to meet the PTLs presented in Table 4-4. Sample analysis will commence with the suspected lowest contaminated sample to the most contaminated sample to minimize potential instrument cross-contamination and false positives.

The procedures for sample collection and for performing all related field activities are described in the Field Sampling Plan. Proposed methods are consistent with standard sampling protocols identified in the USEPA document titled, "Field Methods Compendium" (OSWER Directive 9285.2-11).

5.1 SAMPLE CONTAINERS, PRESERVATION AND SAMPLE HOLDING TIMES

Appropriate sample containers, preservation requirements, sample holding times and shipping means are consistent with the requirements specified in the USEPA approved methods being used for this program; these requirements are discussed in Section 6.

5.2 DECONTAMINATION PROCEDURES

Procedures to be used for decontamination of all sampling equipment including drill rigs, Geoprobe® samplers and groundwater sampling equipment are discussed in Section 7 of the Field Sampling Plan.

The purpose of sample management is to create a "cradle to grave", legally defensible, traceable and documented chain-of-custody (COC) for samples from the time of collection in the field through shipment, receipt by the laboratory, and final receipt of analytical data by URSGWC. A permanent copy of the COC forms for samples submitted for off-site commercial laboratory analyses will be maintained by the laboratory as part of the data package, and by URSGWC in the project files.

6.1 FIELD DOCUMENTATION

In the field, a logbook will be maintained by the field sampler. A bound field logbook will be used by URSGWC to record all pertinent field data collection activities or observations made. Documentation in this field logbook will be sufficient to reconstruct the sampling situation without relying on the memory of the field team members. Entries into the field logbook will include, but are not necessary limited to the following information:

- Project name
- Date and time
- Sample location
- Sample number
- Sample depth
- Media type
- Organic vapor readings
- Sampling personnel present
- Type of health and safety clothing/equipment used
- Analyses requested
- Time of sample collection
- Sample preservation
- Field observations, to include soil description (if relative)
- Weather conditions
- Depth to water
- Other project-specific information

In addition, field sketches will be made in the field logbooks when appropriate, with reference points tied to existing structures in the area (i.e., trees, fence posts, etc.).

Field logbooks will be identified by a project-specific number (i.e., Logbook #1 for Project Number 3808E060216.00) and stored in the field project files when not in use. At the completion of the field activities, the logbooks will be maintained in the central project file.

6.2 SAMPLE IDENTIFICATION AND LABELING

Each sample collected will be assigned a unique sample identification number and placed in the appropriate sample container. The sample numbering system will provide a tracking number to allow retrieval and cross-referencing of sample information. The sample numbering system is summarized in section 4 of the Field Sampling Plan. Each sample container will have a sample label affixed to the outside with the date, time of sample collection, site name, and type of sample. In addition, this label will contain the sample identification number, analysis required, and chemical preservatives added, if any. All documentation will be completed in waterproof ink.

6.3 SAMPLE CONTAINERS

URSGWC will collect samples for off-site commercial laboratory analyses in containers appropriate for the matrix being sampled and the parameters being analyzed. URSGWC will acquire commercially cleaned (to USEPA standards) sample containers from the subcontracted laboratory. This laboratory will also supply the sample preservatives. Appropriate sample containers for the specified analyses being performed are presented in Table 6-1.

6.4 SAMPLE PRESERVATION AND HOLDING TIMES

Sample preservation efforts will commence at the time of sample collection and will continue until analyses are performed. Samples collected for laboratory analyses will be stored on ice at 4°C in coolers immediately following collection. Where appropriate, sample preservatives will be included in sample containers supplied by the laboratory. The sample preservation and holding time requirements are also presented in Table 6-1.

6.5 CHAIN-OF-CUSTODY PROTOCOL

URSGWC has established a program of sample chain-of-custody that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of chain-of-custody procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Field Investigation Leaders or designee will be responsible for monitoring compliance with chain-of-custody procedures.

Chain-of-custody refers to the actual possession of the samples. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

6.5.1 Field Protocol

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Initial information concerning collection of the samples will be recorded in the field logbook. Information on the custody, transfer, handling, and shipping of all samples will be recorded on a COC form. An example COC form is shown on Figure 6-1.

The sampler will be responsible for initiating and filling out the COC form. The field team members are responsible for the care and custody of the samples collected until the samples are transferred to another individual or shipped to the laboratory. The field team, under the direction of the Field Investigation Leaders, is responsible for enforcing COC procedures during fieldwork. The COC form will be signed, with date and time, by the sampler and when the sampler relinquishes the sample to anyone else. COC forms will accompany the samples at all times. All individuals who subsequently take possession of the samples will also sign, with date and time, the COC form. Each cooler containing samples shipped to the laboratory will be accompanied by a COC form. The COC will contain the following information:

- Sampler's signature and company affiliation
- Project name and number
- Date and time of collection
- Sample identification number
- Sample type
- Sample media
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)
- Required turnaround time

The COC procedures are provided below:

- At the time of sample collection, the COC form is completed for the sample collected. The sample identification number, date, type of sample (i.e., grab or composite), sample media, and analysis requested is recorded on the form.
- When the form is full or when all samples have been collected that will fit in a single cooler, the field team members will crosscheck the form for possible errors and sign the COC form. Corrections are made to the record with a single strike mark and dated and initialed. All entries will be made in blue or black waterproof ink.
- A shipping bill is completed and the shipping bill number recorded on the COC form prior to placing the COC form inside a clear plastic bag and attaching it to the inside of the cooler lid.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing, with date and time, the COC. Samples are packaged for shipment and dispatched to the analytical laboratory with a separate COC form accompanying each cooler.

A copy of each COC form will be retained by the sampling team for the project file and the original is sent with the samples. Bills of lading will also be retained as part of the documentation for the chain-of-custody records.

6.5.2 Laboratory Protocol

Upon arrival in the laboratory, samples will be checked in by the sample custodian. The sample custodian will:

- Verify that the number of samples received in the shipment agrees with the number listed on the COC form.
- Verify that the information on each sample bottle agrees with the information documented on the COC form.
- Document on the COC form that the sample bottles are intact and the condition (such as container temperature or evidence of custody seal tampering) of all samples received.

In the event of discrepancies with the COC form or problems with shipping or receiving, the laboratory Project Manager will notify URSGWC immediately. A unique laboratory sample number will be assigned to each sample. The laboratory identification number and the date received will be entered into the laboratory's data management system along with pertinent information from the COC form: sample number, sample date, sample location, sample description, and requested analyses. The laboratory data management system will maintain a record of the status of the samples, requests for modification of any analyses, sample storage locations, the status of QA review, and the analytical results.

Shrader, the laboratory chosen to perform the chemical analyses, has sample receipt procedures, sample preparation and analytical database tracking procedures, and security procedures which safeguard sample integrity.

After analysis, groundwater sample material will be retained by the laboratory until written notice is given to dispose of the samples. Once analyses have been delivered, URSGWC will determine if sample disposal is appropriate. URSGWC will obtain permission for disposal from BASF.

6.6 SAMPLE SHIPMENT

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations.

6.6.1 Packaging

Sample containers will be packed in bubble wrap to minimize the possibility of breakage and placed in metal or plastic coolers. Frozen "blue ice" packs or double "Ziploc" bags of ice will be placed around sample containers. Additional cushioning material will be added to the cooler, if necessary. Paperwork will be put in a "Ziploc" bag and placed on top of the sample containers/blue ice or taped to the inside lid of the cooler. The cooler will be taped closed and signed custody seals will be affixed to two sides of the cooler. Laboratory address labels will be placed on top of the cooler.

6.6.2 Shipping

Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below:

- All environmental samples collected will be transported to the laboratory by URSGWC personnel or shipped through Federal Express or equivalent overnight service.
- Shipments will be scheduled to meet holding time requirements.
- The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

6.7 PROJECT FILE

A central project file, containing complete project documentation of all aspects of the activities associated with the investigation will be maintained by the URSGWC Site Assessment Managers. This file will, at a minimum, include:

- Project plans and specifications
- Field logbooks and data records
- Maps and drawings
- Sample identification documents
- COC records
- The entire analytical data packages, including QC documentation
- Data validation reports
- Selected reference and literature
- Report notes and calculations
- Progress and technical reports
- Correspondence

Project documentation will be checked for completeness to include peer reviews, before placement into the file.

7.1 FIELD INSTRUMENT CALIBRATION

The instruments which will be used to make measurements in the field are the following:

URSGWC Operated Field Equipment

- Portable pH meter with thermometer
- Portable field conductivity meter
- Portable oxidation-reduction (Redox) potential meter
- Portable dissolved oxygen (DO) meter
- OVA or HNu (for sample screening and health and safety purposes)

The above instruments and equipment used by URSGWC during the field related activities will be operated, calibrated and maintained according to manufacturer's guidelines and recommendations. Operation and calibration of the field instruments will be performed by URSGWC personnel properly trained in these procedures and will be documented in an appropriate logbook and placed in the project file at completion of field activities.

Calibration of the field instruments will always be performed on a daily basis and the stability of the calibration will be verified during sampling activities.

Equipment that fails calibration or becomes inoperable during use will be removed from service and segregated to prevent inadvertent utilization. The equipment will be properly tagged to indicate that it is out of calibration. Such equipment will be repaired and recalibrated to approved QA standards by qualified personnel, as appropriate. Equipment that cannot be repaired will be replaced.

7.2 LABORATORY INSTRUMENT CALIBRATION

Calibration of laboratory analytical instruments will be performed on a matrix specific basis according to the calibration procedures stipulated within the particular analytical method being followed. The analytical methods to be used are included in Section 8 of this QAPP.

Documentation of all calibration activities will be maintained by the laboratory and will also be submitted with the data packages when required or as requested. This information will become a part of the central project record and could be retrieved as necessary.

Groundwater samples collected during the EE/CC Program will be analyzed for select volatile organic compounds (VOCs), semi-VOCs, metals, ammonia and cyanide in accordance with approved USEPA analytical methods. Additionally, any groundwater samples collected from well MW-B will be analyzed for PCBs in accordance with approved USEPA analytical protocols. The compounds/analytes that will be analyzed include:

VOCs	SVOCs	PCBs	Inorganics
acetone	acenaphthene	Aroclor-1016	arsenic
methylene chloride	benzo(a)pyrene	Aroclor-1221	chromium
vinyl chloride	bis(2-ethylhexyl)phthalate	Aroclor-1232	lead
total xylenes	2,4-dimethylphenol	Aroclor-1242	mercury
	fluorene	Aroclor-1248	ammonia
	2-methylphenol	Aroclor-1254	cyanide
	naphthalene	Aroclor-1260	
	pentachlorophenol		
	phenanthrene		
	phenol		

Table 8-1 summarizes the sample preparation and analysis methods that Shrader Laboratories will use during the investigation. Should the methods cited in Table 8-1 be changed, either by issuing agency or through public notice in the Federal Register, the laboratory methods will be updated accordingly.

Analytical data generated by Shrader Laboratories will be evaluated for precision, accuracy, representativeness, comparability and completeness. The data quality review process for this project will consist of data generation, reduction, and two levels of review.

9.1 DATA REDUCTION

The first round of review, will be conducted by Shrader's data reviewer who has initial responsibility for correctness and completeness of the data. All data generated by Shrader will be reduced in accordance with USEPA SW-846 protocols and Shrader's SOP. The laboratory will evaluate their work quality, based on established set of guidelines and this QAPP. Shrader's data reviewer will evaluate the data packages to ensure that:

- Sample preparation information is correct and complete
- Analysis information is correct and complete
- The appropriate SOPs have been followed
- Analytical results are correct and complete
- QC samples and criteria are within established control limits
- Blanks are within appropriate QC limits
- Special sample preparation and analytical requirements have been met
- Documentation is complete (all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete; holding times are documented)

Shrader will perform in-house analytical data reduction and QA review under direction of a data review supervisor. Shrader will be responsible for assessing data quality and advising the URSGWC Site Assessment Managers of data that were rated "preliminary" or "unacceptable", or other notations that would caution the data user of possible unreliability. Data reduction, QA review, and reporting by the laboratory will be conducted as follows:

- Raw data produced by the analyst will be processed and reviewed for attainment of quality control criteria as outlined in the QAPP and/or established analytical methods or SOPs and for overall quality.
- After entry into the laboratory information management system, a computerized report will be generated and sent to the laboratory data reviewer.
- The data reviewer will decide whether any sample reanalysis is required.
- Upon acceptance of the preliminary reports by the data reviewer, data reports will be generated.

9.2 REPORTING DELIVERABLES

The laboratory will prepare and retain full analytical and QC documentation. The task of reporting laboratory data to the MDEQ begins after the validation activity has been concluded.

The laboratory Project Manager will perform a final review of the report summaries and case narratives to determine whether the report meets the project requirements. In addition to the record of the chain-of-custody, the report format shall consist of the following:

1. Case Narrative
   - i) date of issuance
   - ii) laboratory analysis performed
   - iii) any deviations from intended analytical strategy
   - iv) laboratory batch number
   - v) number of samples and respective matrices
   - vi) quality control procedures utilized and also references to the acceptance criteria
   - vii) laboratory report contents
   - viii) project name and number
   - ix) condition of samples "as received"
   - x) discussion of whether or not sample holding times were met
   - xi) discussion of technical problems or other observations which may have created analytical difficulties
   - xii) discussion of any laboratory quality control checks which failed to meet project criteria
   - xiii) signature of laboratory QA Manager

2. Chemistry Data Package
   - i) case narrative for each analyzed batch of samples
   - ii) cross referencing of laboratory sample to project sample identification numbers
   - iii) description of data qualifiers to be used
   - iv) methods of sample preparation and analyses for samples
   - v) sample results
   - vi) raw data for sample results and laboratory quality control samples
   - vii) results of (dated) initial and continuing calibration checks and GC/MS tuning results
   - viii) surrogate spike recoveries, internal standard recoveries, matrix spike and matrix spike duplicate recoveries, laboratory control samples, method blank results, interference check sample recoveries, and serial dilution results

ix) labeled and dated chromatograms/spectra/instrument output of sample results and laboratory quality control checks

The data package submitted will be a "CLP-like" data package consisting of all the information presented in a CLP data package but not necessarily on CLP forms.

9.3 DATA VALIDATION

The second level of review will be performed by the URSGWC QA Officer or qualified designee, whose function is to provide an independent validation of the data package. The data will be fully validated to determine conformance with the analytical methods used for analysis. The protocols established in this QAPP and in the following USEPA documents will be used as guidance during the data validation process:

1. U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, February 1993.
2. U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994.

The second level of review will be structured to ensure that:

- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of sample components is correct.
- Quantitative results are correct.
- Transcription errors are not present.
- Documentation is complete and correct (all anomalies in the preparation and analysis have been documented); holding times are documented.
- The data are ready for incorporation into the final report.
- The data package is complete and ready for data archival.

Upon completion of the data validation effort, the URSGWC QA Officer, or qualified designee, will submit a final report covering the overall assessment of the data quality. The reports will include:

- A general assessment of the data package as it pertains to completeness and compliance.
- Descriptions of any and all deviations from the required protocol.
- An assessment of outliers and affect of the outliers on the overall usability of the data.

- Identification of applicable data qualifiers, including, if necessary, rejection of non-compliant data.

10.1 FIELD QC

Quality control procedures for field measurements will be accomplished by documenting the reproducibility and measurements in the field by obtaining multiple readings and by calibrating each instrument used in the field (where appropriate).

Quality control of field sampling will involve the collection of field duplicates and trip blank samples in accordance with the applicable procedures described in the Field Sampling Plan and in accordance with the frequencies provided in Section 4.2.1.

10.1.1 Field Duplicate Samples

Field duplicate samples are made by splitting an individual sample between two sets of sample containers. Field duplicate samples are expected to contain similar contaminant concentrations. Variability in the reported analyses is attributable to subsample variability or variability introduced by sampling, handling, or analytical procedures. The analysis of field duplicate samples provides an estimate of the aggregate sampling and analytical precision. Subsample variability is not expected to be significant for groundwater samples, but may be significant for soil samples. Field duplicate samples will be submitted "blind" to the laboratory.

10.1.2 Trip Blank Samples

Trip blank samples consist of two 40-ml glass vials with septum-lined lids which are filled with analyte-free water from the laboratory. These filled vials will be packed and shipped from the laboratory with the empty sample containers and subsequently returned to the laboratory with the same set of sample containers they accompanied to the field. Trip blank samples will be analyzed for the same set of VOCs as the samples which they accompany. Results of the trip blank analyses will be used to determine whether contaminants may have been introduced during the sample shipping process.

10.2 LABORATORY QC

Internal QC procedures for laboratory analyses will be conducted in a manner consistent with the USEPA approved methods cited in Table 8-1. These procedures include the types of internal QC analyses required, the frequency of each analysis, the compounds or analytes to be used for QC sample analysis and the QA acceptance criteria for these analyses.

Laboratory internal QC checks for laboratory analyses include, but are not limited to, the analysis of matrix spike and matrix spike duplicate samples, method blank samples, surrogate compounds, internal standards, check samples and calibration verification standards in combination with instrument calibrations.

Internal audits may be performed, as appropriate, throughout the duration of the investigation. The objectives of the system and performance audits are to ensure that the quality assurance program developed for this project is being implemented according to the specified requirements, to assess the effectiveness of the quality assurance program, to identify non-conformances, and to verify that any identified deficiencies are corrected. If any significant deviations from the QAPP are documented, corrective action measures will be implemented and documented as detailed in Section 14. Reports to be prepared at the completion of an audit are described in Section 15.

11.1 SYSTEM AUDITS

11.1.1 Field System Audit

A field system audit may be conducted by URSGWC's QA Officer or qualified designee during the initial sampling activities. If a field system audit is conducted, the field auditor would carefully review the field equipment selection and use to ensure that the equipment is capable of performing the desired functions. Equipment selection review would be based on the capabilities and limitations of the instrument/sampling device. Use would be reviewed based on observations and comparisons of actual versus expected results. In addition, the field auditor would meet with key field staff to review the field sampling program and evaluate the need for changes which may improve the results.

The field auditor will provide an oral report summarizing the results of the audit to the Site Assessment Managers within five working days of the audit. A written report documenting all activities associated with the field system audit will be provided to the Site Assessment Managers within ten working days after completion of the audit. The report will document audit findings, on-site meetings, and program revisions as necessary.

It is anticipated that the field system audit, if conducted, will be performed soon after field start-up to identify and rectify any potential problems early in the program. If changes to the approved QAPP are necessary following start-up of the field activities and completion of the initial field system audit, additional field system audits may be conducted during subsequent sampling activities.

11.1.2 Laboratory System Audit

A laboratory systems audit may be conducted by the URSGWC QA Officer or qualified designee during analysis of initial sample shipments sent to the laboratory. If a laboratory systems audit is conducted, the URSGWC QA Officer, in conjunction with the Project Manager representing the subcontracted laboratory, would ensure that documentation is available to verify that instrumentation required by the analytical methods were used in the analysis of samples, and that the instruments were functioning properly. This initial audit would also include a review of the analytical methods proposed for use and the laboratory Standard Operating Procedures (SOPs) prepared from the methods. The laboratory Project Manager or his/her designee will make changes as necessary following the initial laboratory systems audit. The laboratory Project Manager will confirm orally within one working day and in writing within five working days to the URSGWC Site Assessment Managers and/or QA Officer, that the laboratory meets all requirements of the measurement system.

11.1.3 Office System Audit

Office system audits will be conducted as part of the overall URSGWC Quality Assurance Program. The office audit consists of reviewing the project file and verifying that data collected is being presented, reviewed, and filed in accordance with this QAPP. The URSGWC QA Officer will be responsible for conducting office system audits of this project as part of regular duties. The QA Officer will present the findings to the Site Assessment Managers if further action is required.

11.2 PERFORMANCE AUDITS

Performance audits are usually conducted after data production systems are operational and are generating data. Performance audits consist of two types: internal and external.

URSGWC will submit internal performance audit check samples to the subcontracted laboratory. The samples will consist of blanks and duplicates as described in this QAPP. Some duplicate samples may be used by the laboratory for matrix spike analysis. Analytical results from these internal performance audit samples will be used throughout the project to assess data from environmental samples for accuracy and precision.

External performance audit check samples are samples submitted by external regulatory agencies to assess whether a contractor's laboratory is generating data within acceptable control limits. If external performance audit check samples are provided by MDEQ, URSGWC's subcontracted laboratory will analyze the samples and provide analytical results along with results of the environmental samples.

All equipment and instruments will have a prescribed routine maintenance schedule in addition to a calibration schedule to ensure reliable analytical data is generated for this project. Preventive maintenance will be performed and documented by qualified project personnel.

12.1 FIELD INSTRUMENTS

All field instrumentation, sampling equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications and established field practice. All maintenance will be performed by qualified project personnel and will be documented by the appointed equipment manager of his designee.

The Field Investigation Leaders and Site Health and Safety Officer will review calibration and maintenance records on a regular basis to ensure that required maintenance is occurring. These activities will be recorded in the field logbook to document that established calibration and maintenance procedures have been followed. Field instruments will be checked and calibrated prior to their use on-site, and batteries will be charged and checked daily where applicable. Table 12-1 summarizes the frequency of service for field instruments.

12.2 LABORATORY INSTRUMENTS

Shrader Laboratories is responsible for the maintenance of laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize downtime and the potential interruption of analytical work. All instruments will be maintained in accordance with manufacturer's recommendations and normal approved laboratory practice.

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be performed by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. Shrader has instruments which will serve as backups to minimize the potential for downtime. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. Designated laboratory operations coordinators will review maintenance records on a regular basis to ensure that required maintenance is occurring. Table 12-1 summarizes the frequency which components of key analytical instruments or equipment will be serviced.

13.1 INTRODUCTION

The reliability and credibility of analytical laboratory results are evaluated by the inclusion, as an integral part of any analytical procedure, of a program of randomly selected duplicate analyses, analysis of standards or spiked samples, and the utilization of trip blank samples.

Precision of analytical results will be evaluated as the relative percent difference (RPD) between laboratory or field duplicate samples analyses. Accuracy is reported as the percent recovery of a parameter from a sample of known value with a given analytical procedure.

The procedures described below are designed to evaluate precision and accuracy for each analytical method. For reliable data to be produced, systematic checks must show that test results remain reproducible and that the methodology is actually measuring the quantity of analyte in each sample. Quality assurance must begin with sample collection and not end until data results have been assessed.

Data validation will be accomplished by the URSGWC QA Officer and/or designees. The URSGWC QA Officer or designees will review the analytical results for compliance with the established acceptance criteria of each particular method. Problems associated with sample collection, packing, shipping, or analysis will be taken into consideration in evaluating the quality of the data.

Sections 13.2, 13.3 and 13.4 list the procedures that will be used to evaluate data precision, accuracy, and completeness for the analyses conducted.

13.2 ACCURACY

Accuracy will be expressed as percent recovery (%R) for laboratory control samples as follows:

$$\text{Percent Recovery} = \frac{x}{T} \times 100$$

where: x = the observed value of measurement

T = "true" value

These recoveries will be compared with the control limits and the outliers will be assessed in conformance with other QC data. Surrogate recoveries will also be calculated as above and compared against control limits of each method. If the surrogate percent recoveries are outside control limits, the data will be assessed as specified in the appropriate validation guidelines.

In addition, the matrix spike and matrix spike duplicate sample results will be used to calculate the percent recovery.

$$\text{Percent Recovery (for matrix spikes)} = \frac{X - S}{T} \times 100$$

where: X = observed value after spike

S = sample value

T = amount spiked

Matrix spike and matrix spike duplicate percent recoveries will be compared to limits specified in the applicable method and the data assessed as specified in the appropriate validation guidelines.

13.3 PRECISION

Precision will be expressed as relative percent difference (RPD) for duplicate environmental samples, and matrix spike/matrix spike duplicate sample analyses, as follows:

$$RPD = \frac{|S - D|}{(S + D)/2} \; x \; 100$$

where: S = first sample value (original)

D = second sample value (duplicate)

The RPDs will be compared against the limits of the applicable method and the data assessed as specified in the appropriate validation guidelines. Where no guidelines or criteria exist, professional judgment will be used in assessing the data.

13.4 ASSESSMENT OF DATA FOR COMPLETENESS AND USABILITY

Following validation of the data packages, assessment of the data with respect to fulfillment of quality assurance objectives will be accomplished by the joint efforts of the URSGWC QA Officer and Site Assessment Managers. This assessment will consider sample collection, sample handling, field data, validated blank values and field duplicate values, and additional data flags or qualifiers specified to each set of data.

The analytical completeness will be calculated by the ratio of accepted analytical results (including estimated values) to the total number of analytical results requested on samples submitted for analysis. The equation for analytical completeness is:

$$\% \text{ Completeness} = \frac{\text{Accepted Analytical Results}}{\text{Total Number of Analytical Results Requested}}$$

Completeness for laboratory analyses will be determined by matrix for each analytical method as compared to historical completeness data available for the methods. USEPA methods similar to those that will be used for this project have historically yielded data that are between 80-85% complete. A completeness goal of 90 percent will be established for the analysis of samples for this investigation.

The URSGWC QA Officer and Site Assessment Managers will decide if the data are sufficient and complete for its intended use. If it is judged that the data are inadequate, additional field samples will be collected to accomplish the study goals. Decisions to repeat sample collection and analysis may be made by the Site Assessment Managers and QA Officer based on the extent of deficiencies and their importance to the overall objectives of the study.

14.1 INTRODUCTION

Corrective actions may be required for two classes of problems: analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

For noncompliance problems, formal corrective action will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the URSGWC Site Assessment Managers and QA Officer. Implementation of corrective action will be confirmed in writing through the same channels.

Any non-conformance with established quality control procedures in this QAPP will be identified and corrected in accordance with this QAPP. The URSGWC QA Officer or designee will issue a Non-conformance Report for each non-conformance condition.

Corrective actions will be implemented and documented in the field logbook. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the URSGWC Site Assessment Managers or QA Officer.

14.2 FIELD CORRECTIVE ACTION

Technical staff and project personnel will be responsible for reporting all suspected technical or QA non conformance or suspected deficiencies of any activity or issued document by reporting the situation to the Field Investigation Leaders or designee. The Field Investigation Leaders will be responsible for assessing the suspected problems in consultation with the URSGWC QA Officer and Site Assessment Managers and making a decision based on the potential for the situation to impact the quality of the data. If the situation warrants a corrective action, then a non-conformance report will be initiated by the Field Investigation Leaders.

The Field Investigation Leaders will be responsible for ensuring that corrective action for non conformances are initiated by:

- evaluating all reported non conformance's;
- controlling additional work on non conforming items;
- identifying disposition or action to be taken;
- maintaining a log of non-conformance's;
- reviewing non-conformance reports and corrective actions taken; and
- ensuring non-conformance reports are included in the final site documentation in project files.

If appropriate, the Field Investigation Leaders will ensure that no additional work that is dependent on the non-conformance activity is performed until the corrective actions are completed.

Corrective action for field measures may include:

- Repeat the measurement to check the error;
- Check for all proper adjustments for ambient conditions such as temperature;
- Check the batteries;
- Re-calibration.
- Replace the instrument or measurement devices; and
- Stop work (if necessary).

The Field Investigation Leaders are responsible for all site activities. In this role, the Field Investigation Leaders are at times, required to adjust procedures to accommodate site-specific needs.

Any change in procedures will be documented and signed by the initiators and the Field Investigation Leaders. Each document will be numbered serially as required, and attached to the field copy of the affected document.

The Field Investigation Leaders are responsible for the controlling, tracking, and implementation of the identified field changes. Reports on all changes will be distributed to all affected parties. The URSGWC Site Assessment Managers and BASF will be notified whenever program changes in the field are made.

14.3 LABORATORY CORRECTIVE ACTION

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions, such as broken samples containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or just prior to analysis. Following consultation with lab analysts and section leaders, it may be necessary for the laboratory's Quality Assurance Officer to approve the implementation of corrective action. The submitted SOPs specify some conditions during or after analysis that may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, automatic reinjection/reanalysis when certain quality control criteria are not met, etc.

The bench chemist will identify the need for corrective action. The Shrader Laboratories QA Officer in consultation with the Shrader Laboratories supervisor and staff, will approve the required corrective action to be implemented by the laboratory staff. The laboratory QA Officer will ensure implementation and documentation of the corrective action. If the non conformance causes project objectives not to be achieved, it will be necessary to inform all levels of project management, including BASF, to concur with the corrective action.

These corrective actions are performed prior to release of the data from the laboratory. The corrective action will be documented in both the laboratory's corrective action log (signed by analyst, section leader and QA Officer), and the narrative data report sent from the laboratory to the URSGWC QA Officer.

15.1 AUDIT REPORTS

Audit report(s) summarizing the results of system audits will be prepared at the completion of system audit(s). The format of audit reports is variable depending on the type of audit conducted, but will include, at a minimum, the project name, date of the audit, name of the auditor, project aspects audited, results of the audit including any QA deficiencies, and recommendations.

15.2 CORRECTIVE ACTION REPORTS

Any incidents requiring corrective action will be documented. Procedurally, the QA Officer will prepare the reports. These reports will be addressed to the Site Assessment Managers and distributed to the project staff and Peer Reviewer, as appropriate. The summary of findings shall be factual, concise, and complete. Any required supporting information will be appended to the report.

15.3 DATA VALIDATION REPORTS

After the fieldwork has been completed and the final analyses are completed and checked, a data validation report will be prepared. The report will summarize the data validation efforts and provide an evaluation of the data quality in regard to precision, accuracy, and analytical completeness as defined in Section 13 of the QAPP. The URSGWC QA Officer or designee will prepare this final summary and incorporate it as part of the project report.

Concerns which arise during the course of the project that may require changes to the scope of work or deviations from the established protocols specified in the approved project plans will be brought before BASF for discussion and resolution.

TABLE 4-1
SUMMARY OF THE SAMPLING AND ANALYSIS PROGRAM
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Matrix	Field Parameters	Laboratory Parameters	Analytical Methods [1]	Investigative Samples	QC Samples: Field Duplicate Samples [2]	QC Samples: Trip Blank Samples [3]	QC Samples: MS/MSD Samples [4]	Total
Existing Wells & piezometers								
Groundwater	GW Depth & Elevation,	Select VOCs	SW-846 8260	14	2	2	1/1	20
(Per Event)	pH, Temperature, Conductivity	Select SVOCs	SW-846 8270	14	2	NA	1/1	18
	dissolved oxygen	Select field filtered metals	6010/7000 series	14	2	NA	1/1	18
	Redox	PCBs	SW-846 8082	1	1	NA	1/1	4
		ammonia	EPA 350.1	14	2	NA	1/1	18
		Cyanide	SW-846 9012	14	2	NA	1/1	18
New Wells								
Groundwater	GW Depth & Elevation,	Select VOCs	SW-846 8260	12	1	1	1/1	16
(Per Event)	pH, Temperature, Conductivity	Select SVOCs	SW-846 8270	12	1	NA	1/1	15
	dissolved oxygen	Select metals	6010/7000 series	12	1	NA	1/1	15
		ammonia	EPA 350.1	12	1	NA	1/1	15
	Redox	Cyanide	SW-846 9012	12	1	NA	1/1	15
		Geochemical parameters	see note 5					
Groundwater from Geoprobes	NA	Select VOCs	SW-846 8260	5	1	1	--	7
		Select SVOCs	SW-846 8270	5	1	NA	--	6
		Select metals	6010/7000 series	5	1	NA	--	6
		ammonia	EPA 350.1	5	1	NA	--	6
		Cyanide	SW-846 9012	5	1	NA	--	6

TABLE 4-1
SUMMARY OF THE SAMPLING AND ANALYSIS PROGRAM
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Notes:

(1) Refer to QAPP Table 8-1 for complete description of analytical methods.

(2) Field duplicates will be collected at a rate of one per 10 investigative samples.

(3)The total number of trip blanks are estimates only; one trip blank set will be included with each shipping cooler containing samples for VOC analysis.

(4) Matrix spike/matrix spike duplicate samples. These QC samples will be collected at a rate of one per 20 investigative samples.
For aqueous samples, triple the normal volume is required for VOCs and double sample volume is required for SVOCs.

(5) Selected wells may be analyzed for CO_2, NO_3, phosphate, methane, SO_4, total and ferrous iron, chloride, alkalinity and hardness.
These parameters will be analyzed by the BASF laboratory in Wyandotte, Michigan.

(6) Field rinsate blanks are not required since samples will be collected using dedicated sampling equipment with disposable filtering equipment.

NA - Not applicable
VOCs-Volatile organic compounds
SVOCs-Semivolatile organic compounds

TABLE 4-2
SHRADER LABORATORIES
PRECISION AND ACCURACY CONTROL LIMITS
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

ANALYSES	Water Control Limits	
	% Recovery Limits	Relative % Difference
VOCs (8260):		
acetone	72-115	20
methylene chloride	75-125	20
vinyl chloride	60-124	20
xylenes	60-120	20
SVOCs (8270):		
acenaphthene	66-102	20
fluorene	70-130	20
naphthalene	46-125	20
pentachlorophenol	42-150	20
phenanthrene	70-130	20
phenol	11-105	20
PCBs (8082):		
Aroclor-1254	52-100	30
Metals (6010/7000 series):		
arsenic	80-120	20
chromium	80-120	20
lead	80-120	20
mercury	80-120	20
Inorganics		
ammonia (350.1)	80-120	20
cyanide (9012)	80-120	20
Notes:		

NA- Not applicable
(1)- RPD control limits between matrix spike/matrix spike duplicate analyses.

TABLE 4-3
SHRADER LABORATORIES
CONTROL LIMITS FOR SURROGATE COMPOUNDS
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Analytical Method	Surrogate Compound	Water Recovery Limits(%)
VOCs (8260):		
8260	toluene-d_8	83-113
8260	bromofluorobenzene	69-129
8260	1,2-dichloroethane-d_4	70-130
8260	dibromofluoromethane	70-136
SVOCs (8270):		
8270	nitrobenzene-d_5	42-120
8270	2-fluorobiphenyl	53-125
8270	terphenyl-d_{14}	52-142
8270	phenol-d_5	15-105
8270	2-fluorophenol	34-106
8270	2,4,6-tribromophenol	34-124
PCBs (8082):		
8082	biphenyl -$d1_0$	18-84
8082	tcmx	45-93

TABLE 4-4
AQUEOUS PROJECT TARGET LIMITS
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Target Compounds	Project Target Limits Water µg/l
VOCs (8260)	
acetone	100
methylene chloride	5
vinyl chloride	1
xylenes (total)	3
SVOCs (8270)	
acenaphthene	5
benzo(a)pyrene	5
bis(2-ethylhexyl)phthalate	5
fluorene	5
naphthalene	5
pentachlorophenol	2*
phenanthrene	5
2-methylphenol	5
2,4-dimethylphenol	5
phenol	5
PCBs (8082)	
Aroclor-1016	0.2
Aroclor-1221	0.2
Aroclor-1232	0.2
Aroclor-1242	0.2
Aroclor-1248	0.2
Aroclor-1254	0.2
Aroclor-1260	0.2
Metals (6010/7000 series)	
arsenic	20
chromium	5
lead	3.0
mercury	0.2
Inorganics	
ammonia (350.1)	50
cyanide (9012)	5

* The Project target Limit has been lowered from the MDEQ requirement of 20 µg/l to 2 µg/l based on the GSI value of 2.8 µg/l.

TABLE 6-1
CONTAINER, PRESERVATION, SHIPPING AND PACKAGING REQUIREMENTS
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Analysis	Sample Containers	Preservation	Maximum Holding Time	Volume of Sample	Shipping Means	Packaging
Aqueous 1) VOCs	3 x 40 ml glass	HCl to pH<2, Cool to 4° C	14 days from collection.	Fill completely	Overnight	Bubble Pack
2) SVOCs	2 x 1 Liter amber glass bottles	Cool to 4° C	7 days from collection to extraction, 40 days from extraction to analysis.	Fill to neck of bottles	Overnight Courier	Bubble Pack
3) PCBs	2 x 1 Liter amber glass bottles	Cool to 4° C	7 days from collection to extraction, 40 days from extraction to analysis.	Fill to neck of bottles	Overnight Courier	Bubble Pack
3) Metals	1 x 1 liter plastic polyethylene bottle	HNO3 to pH<2, Cool to 4° C	6-months from collection to analysis. Mercury 28 days.	Fill to neck of bottle	Overnight Courier	Bubble Pack
4) Ammonia	1 x 1 liter plastic polyethylene bottle	H2S04 to pH<2, Cool to 4° C	28 days from collection.	Fill to neck of bottle	Overnight Courier	Bubble Pack
5) Cyanide	1 x 1 liter plastic polyethylene bottle	NaOH to pH>12, Cool to 4° C	14 days from collection.	Fill to neck of bottle	Overnight Courier	Bubble Pack

Notes:
(1) Triple sample volume will be required for aqueous matrix spike/matrix spike duplicate analyses.
VOCs-Volatile organic compounds
SVOCs-Semi-volatile organic compounds

TABLE 8-1
SUMMARY OF SAMPLE
PREPARATION AND ANALYSIS METHODS
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

Parameter	Matrix	Preparation Method	Analysis Method
VOCs	Aqueous	SW-846 5030B	SW-846 8260B
SVOCs	Aqueous	SW-846 3510C	SW-846 8270C
PCBs	Aqueous	SW-846 3510C	SW-846 8082
Metals less mercury	Aqueous	SW-846 3010A	SW-846 6010 B
mercury	Aqueous	SW-846 7470A	SW-846 7470A
Ammonia	Aqueous	MCAWW 350.1	MCAWW 350.1
Cyanide	Aqueous	SW-846 9012A	SW-846 9012A

SW 846 - *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition*, EPA, September 1986 and approved updates.

MCAWW - Methods for Chemical Analysis of Water And Wastes, EPA, 1983.

TABLE 12-1
PREVENTIVE MAINTENANCE PROCEDURES FOR FIELD
INSTRUMENTS AND LABORATORY INSTRUMENTATION/EQUIPMENT
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

INSTRUMENT	ACTIVITY	FREQUENCY
FIELD INSTRUMENTS:		
pH Meter	Calibrate	Begining of Each Day
	Check Calibration	Twice Daily
	Immerse Probe in DI water	Each Use
	Replace Batteries	As Needed
Specific Conductance Meter	Calibrate	Begining of Each Day
	Check Calibration	Twice Daily
	Clean Probe	Each Use
	Replace Batteries	As Needed
Thermometer	Inspect Instrument for change	Daily
	Replace Batteries (if digital)	As Needed
OVA/Hnu	Inspect Instrument for change	Daily
	Check Calibration	Twice Daily
	Recharge Batteries	As Needed
	Clean Lamp	As Needed
Dissolved Oxygen Meter	Check Calibration	Daily
	Clean Probe	Each use
	Replace Batteries	As Needed
Redox Meter	Check Calibration	Twice daily
	Clean electrode	Each use
LABORATORY INSTRUMENTS:		
Gas Chromotography and Mass Spectometer	Inspect Septa	Daily, replace as needed
	Clean Injection Port	Daily
	Clean Source	Monthly
	Change Pump Oil	Quarterly
	Clip Column Leader	Daily
	Check Gasses	Daily
	Check for Leaks	As Needed
	Check Autosampler Alignment	Daily

TABLE 12-1
PREVENTIVE MAINTENANCE PROCEDURES FOR FIELD
INSTRUMENTS AND LABORATORY INSTRUMENTATION/EQUIPMENT
EE/CA PROGRAM
BASF RIVERVIEW SITE
RIVERVIEW, MICHIGAN

INSTRUMENT	ACTIVITY	FREQUENCY
Purge and Trap	Inspect Trap	Daily, replace as needed
	Bake Lines	Monthly
	Clean Sample Vessels	Each Use
	Check Gasses	Daily
	Perform Leak Check	As Needed
Inductively Coupled Plasma	Check Aspiration Tube	Daily
	Clean Torch Assembly	Monthly
	Clean Spray Chamber	Monthly
	Check Gasses	Daily
	Clean/Lube Pump Rollers	As Needed
	Check -o-Rings	Monthly
Mercury Cold Vapor Analyzer	Check Tubing	Daily
	Clean Sparger	After Each Sample
	Clean Windows	Monthly
	Change Source Lamp	As Needed
Laboratory Balances	Check Accuracy/Linearity	Weekly
	Calibrate/Certify	Annually/As Needed
Laboratory Ovens	Temperature Monitoring	Daily
	Temperature Adjustments	As Needed
Laboratory Refrigerators	Temperature Monitoring	Twice a Day
	Temperature Adjustments	As Needed

Figures

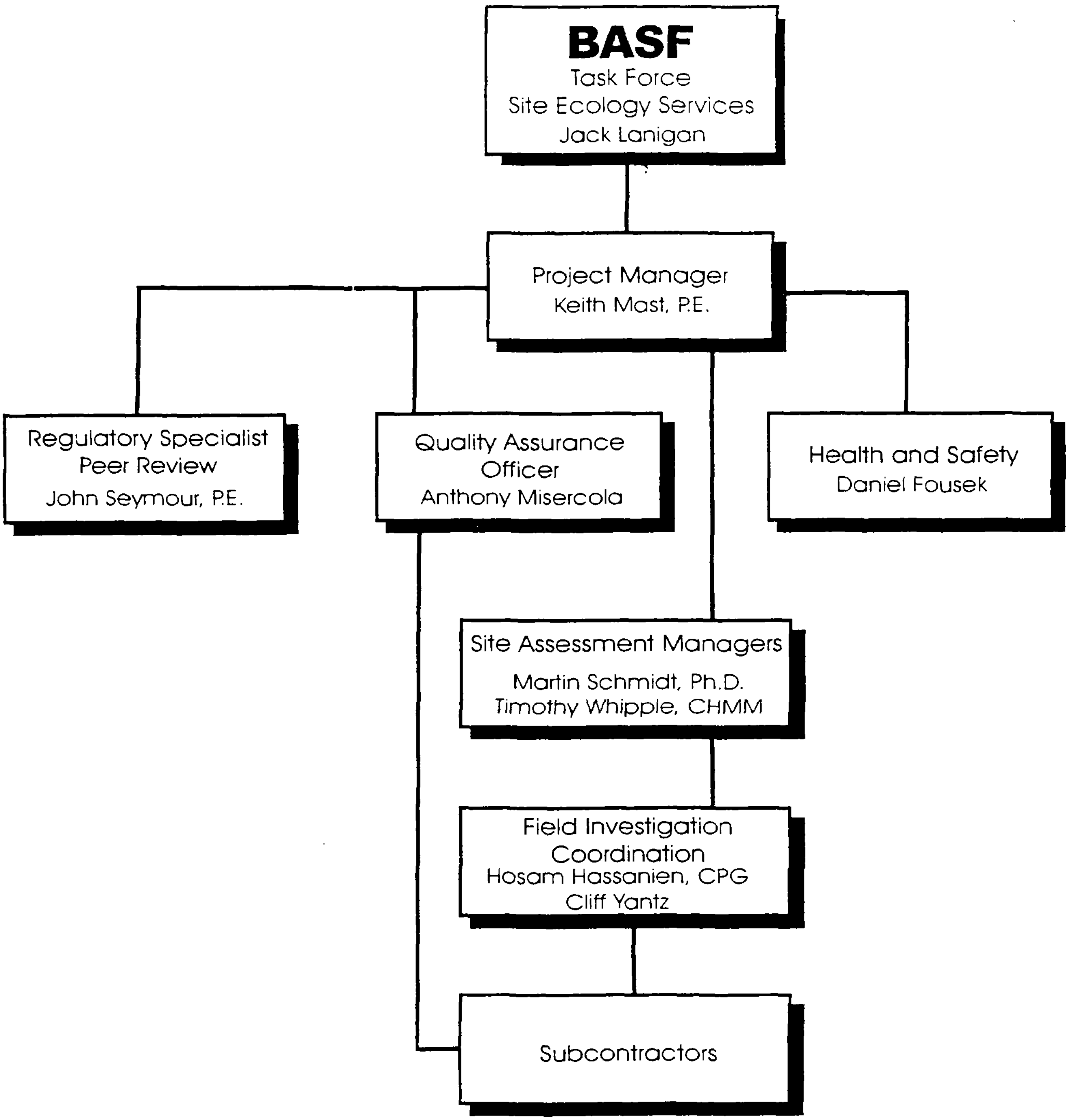


FIGURE 3-1

ORGANIZATIONAL CHART

Chain of Custody Record

Figure 6-1

OUA 4124

Client	Project Manager	Date	Chain Of Custody Number 03819
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page ____ of ____
City / State / Zip Code	Site Contact		
Project Name	Carrier/Waybill Number		
Contract Purchase Order/Quote No.			

Sample I.D. No. and Description	Date	Time	Sample Type	Total Volume	Containers Type	Containers No.	Preservative	Condition on Receipt	Analysis											

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months

Turn Around Time Required
☐ Normal ☐ Rush

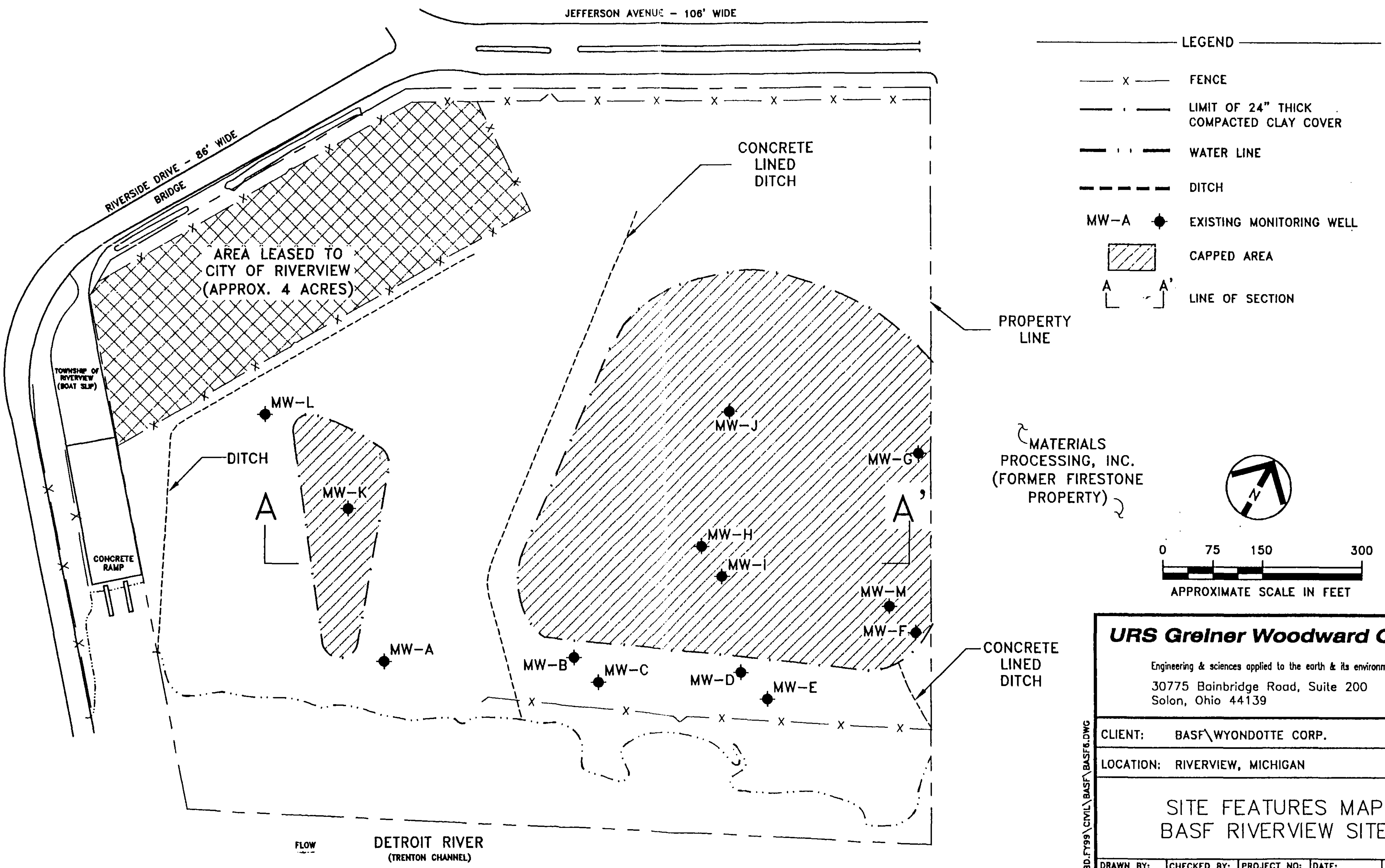
QC Level
☐ I. ☐ II. ☐ III.

Project Specific (Specify)

	Date	Time		Date	Time
1. Relinquished By			1. Received By		
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Stays with Sample; CANARY - Returned to Client with Report; PINK - Field Copy



URS Greiner Woodward Clyde

Engineering & sciences applied to the earth & its environment

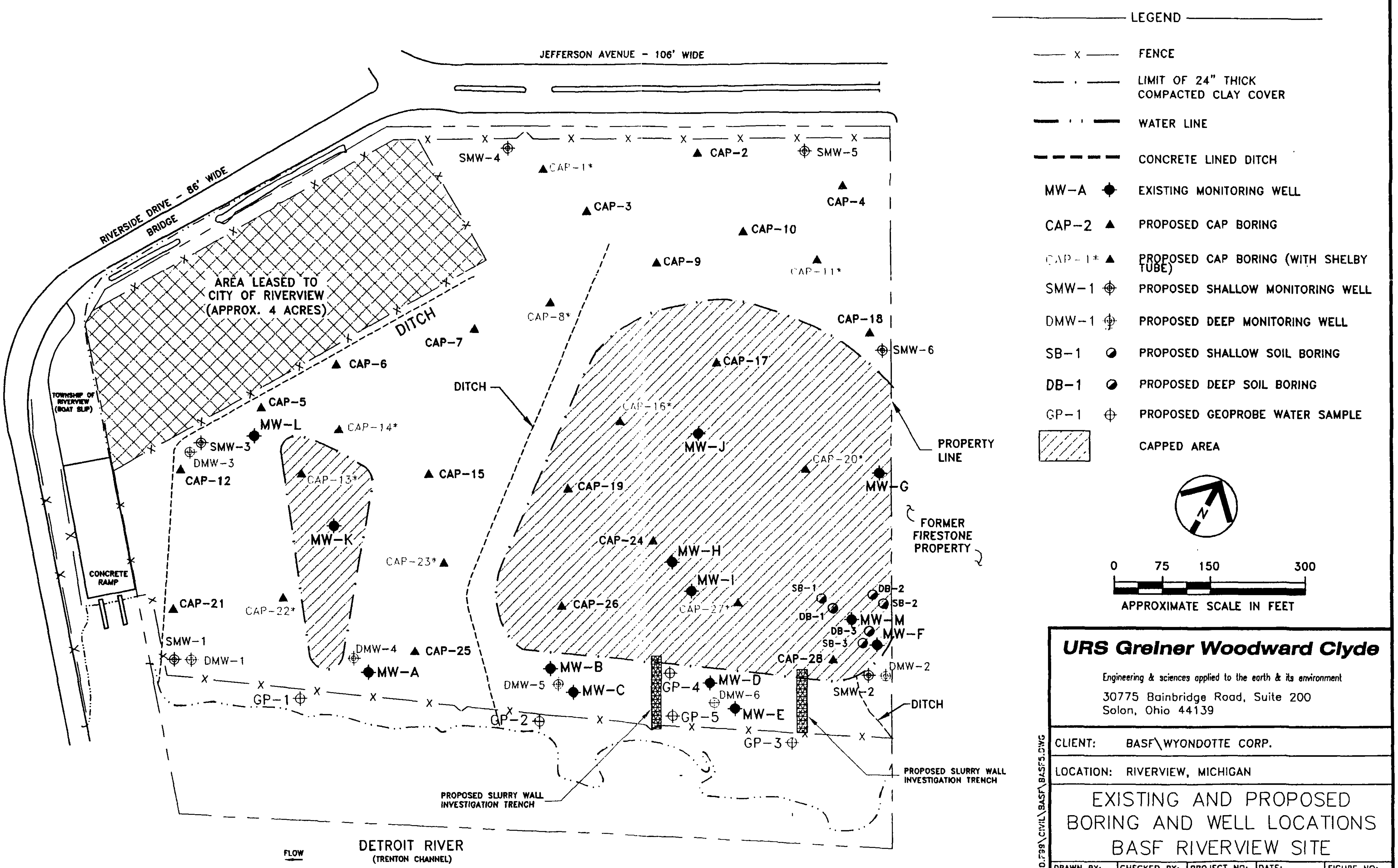
30775 Bainbridge Road, Suite 200
Solon, Ohio 44139

CLIENT:	BASF\WYONDOTTE CORP.
LOCATION:	RIVERVIEW, MICHIGAN

SITE FEATURES MAP
BASF RIVERVIEW SITE

DRAWN BY:	CHECKED BY:	PROJECT NO:	DATE:	FIGURE NO:
SD	KCM	38-08E06216	4/7/99	1-2

W:\BD.FY99\CIVIL\BASF\BASF6.DWG



URS Greiner Woodward Clyde

Engineering & sciences applied to the earth & its environment

30775 Bainbridge Road, Suite 200
Solon, Ohio 44139

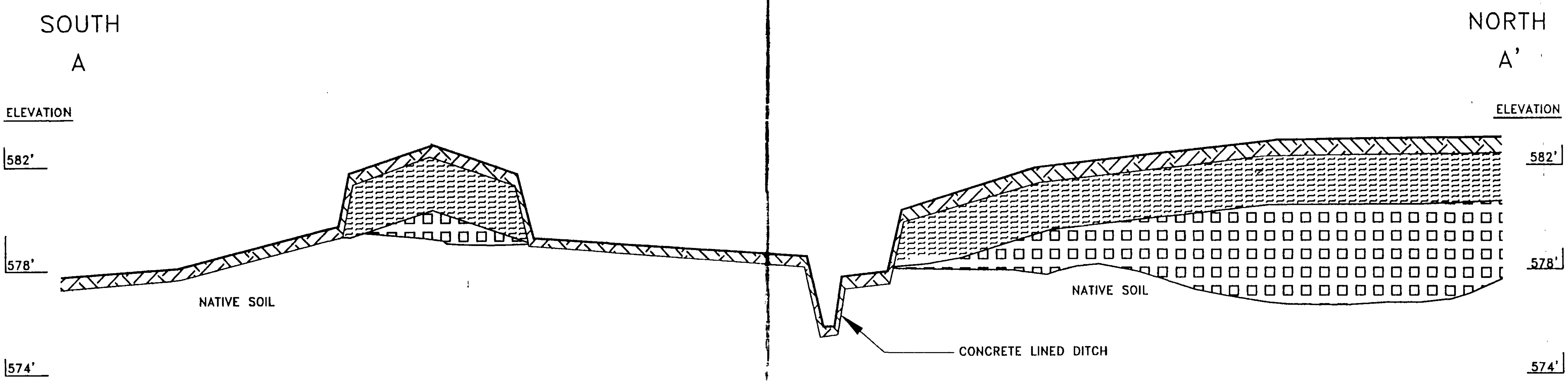
W:\30.F99\CIVIL\BASF\BASF5.DWG

CLIENT: BASF\WYONDOTTE CORP.

LOCATION: RIVERVIEW, MICHIGAN

EXISTING AND PROPOSED BORING AND WELL LOCATIONS BASF RIVERVIEW SITE

DRAWN BY:	CHECKED BY:	PROJECT NO:	DATE:	FIGURE NO:
MMS	MLS	38-8E06216	4/15/99	2-1



LEGEND

- TOPSOIL
- CLAY LINER
- FILL

NOTE: ELEVATIONS AND MATERIAL THICKNESSES ARE APPROXIMATE.

SOURCE:
BASF WYANDOTTE CORPORATION
RIVERVIEW SITE – SITE PLAN FINISHED GRADING
PROJECT No. 89.10.093
DRWING No. 6097.15.7
MAY 1984

0 50 100 200
HOIZONTAL SCALE IN FEET

VERTICAL EXAGERATION = 15X

W:\BD.FY99\CIVIL\BASF\BASFXS3.DWG

URS Greiner Woodward Clyde

30775 Bainbridge Road, Suite 200
Solon, Ohio 44139

CLIENT: BASF\WYANDOTTE CORP.

LOCATION: RIVERVIEW, MICHIGAN

SUBSURFACE CROSS SECTION
PROFILE A - A'
BASF RIVERVIEW SITE

DRAWN BY:	CHECKED BY:	PROJECT NO:	DATE:	FIGURE NO:
SD	KCM	38-08E06216	4/1/99	1-3

Chain of
Custody Record

Figure 6-1

QUA 4124

Client	Project Manager	Date	Chain Of Custody Number 03819
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page ______ of ______
City / State / Zip Code	Site Contact		Analysis
Project Name	Carrier/Waybill Number		
Contract Purchase Order/Quote No.			

Sample I.D. No. and Description	Date	Time	Sample Type	Total Volume	Containers Type	Containers No.	Preservative	Condition on Receipt	Analysis											

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Turn Around Time Required
☐ Normal ☐ Rush

QC Level
☐ I. ☐ II. ☐ III.

Project Specific (Specify)

	Date	Time		Date	Time
1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Stays with Sample; CANARY - Returned to Client with Report; PINK - Field Copy